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TO CONSIDER CURRENT FEDERAL DISASTER RELIEF EFFORTS

HEARING

BEFORE THE

SUBCOMMITTEE ON WATER RESOURCES,
TRANSPORTATION, AND INFRASTRUCTURE

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON

S. 1775

A BILL TO AMEND TITLE 23, U.S. CODE, TO PROVIDE HIGHWAY EMERGENCY RELIEF FOR DAMAGES RESULTING FROM THE NORTHERN CALIFORNIA EARTHQUAKE WHICH OCCURRED ON OCTOBER 17, 1989

OCTOBER 23, 1989

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TO CONSIDER CURRENT FEDERAL DISASTER RELIEF EFFORTS

MONDAY, OCTOBER 23, 1989

U.S. Senate,
Committee on Environment and Public Works,
Subcommittee on Water Resources, Transportation,
and Infrastructure,
Washington, DC.

The subcommittee met, pursuant to notice, at 10:00 a.m., in room 406, Dirksen Senate Office Building, Hon. Daniel P. Moynihan (chairman of the subcommittee) presiding.

Present: Senators Moynihan, Reid, and Symms.

OPENING STATEMENT OF HON. DANIEL PATRICK MOYNIHAN, U.S. SENATOR FROM THE STATE OF NEW YORK

Senator Moynihan. A very good morning to our guests and to our witnesses.

This is a regularly scheduled meeting of the Subcommittee on Water Resources, Transportation, and Infrastructure of the Committee on Environment and Public Works.

Some of you will recall, and our faithful staff members will know, at the beginning of the 100th Congress we reconstituted the old Committee on Public Works into this subcommittee and have proceeded since then.

Good morning to my colleague, Senator Wilson.

In the course of the 100th Congress, we have held a succession of hearings on the general subject of infrastructure. Infrastructure is simply a word that says what is under what you see, what holds things up—like a bridge holds up vehicles that cross it.

We had as our text the report of the National Council on Public Works Improvement, which was issued in final report in February of 1988. This council had been established by this committee in legislation in 1984 in the Public Works Improvement Act of 1984, trying to respond to the obvious fact that we were running down the capital inventory and the capital stock of the country. The economists' phrase for that is disinvestment. You invest and you can disinvest if you are using it up.

As I said, we had the hearings and we had the hearings and we had more hearings. Nobody came. It is a subject that is somewhat difficult to get hold of in the abstract. It takes something like a hurricane or an earthquake to make concrete what we are talking about, whereas that may be only partially the case. What we really are talking about in this committee is the need to begin a major national program of public works development.

In the Highway Act of 1987, the last highway act—technically, the Surface Transportation Act—we put in place the final measures that will complete the interstate highway program. It is the largest public works project in history, an enterprise of extraordinary success. Nothing like it has ever been done. It was done very well, but is now done. Where you see problems, as we did in Oakland, it is those older sections of interstate which were, in fact, built before the interstate and possibly a questionable judgment was made by State officials to trade in existing structures and get revenues for the purposes. One of the results was that you had a portion of the interstate that was built previous to the standards for that construction. Mind you, even those standards can be unavailing in the face of real events of the kind of improbable, unlikely measures which come along quite regularly.

About three years ago in this committee we were dealing with the collapse of a bridge on the New York State Thruway over the Schoharie Creek. The thruway was the prototype for the interstate. Bertram Calloway, who built it and then came down here to build the interstate system, just passed away last month. The Schoharie Creek that this particular portion of interstate crosses is a trout stream. But that morning the amount of water coming down was equal to that which goes over Niagara Falls and the bridge just couldn't handle it.

We take the number developed by the National Council on Public Works Improvement that we are spending about $45 billion a year on infrastructure today, and we need to get it up to $90 billion if we are going to get back to the levels we have been.

I'd like to offer a thought, which is: the running down of our capital plant in this country, the public works of our country, is the flip side of the growing indebtedness. It is a kind of lack of concern for the future that stopped this country in the 1980s in a way I don't know that any of us understand. Mr. Darmon has referred to it as "now-ism." I suppose "now-ism" is better than Maoism, but it is not far from it in consequences. In the 1980s we incurred a national debt equal to 85 percent of the debt that was incurred in the Second World War. We borrowed $2 trillion from the Japanese and gave a party.

But the other form of borrowing was the borrowing which takes place when you do not maintain your highways and your bridges and your dams and your public structure. It is a form of borrowing. It is a form of consuming as against saving. We have tried to make that point in our committee, and we have had little response.

We were struggling against an Administration that wanted to borrow from the Japanese and borrow from the capital stock of the country. It came to the same thing. They would not spend the revenues coming into the Highway Trust Fund. Those are dedicated revenues. President Eisenhower began that program where you paid gasoline taxes. They were put into a fund and committed. They can only be used for one thing, which is infrastructure. But if you don't use them, that somehow means you can spend the money on other things, which is what was done.

And the result is that legislation which we have introduced and this committee has worked on has never had—we have never had so much as a letter from the Administration saying they don't like it. They act as if we are not here. They continue to act as if we are not here. There will be nobody from the Administration at the political level present this morning.

I was on Meet the Press yesterday and spoke of what we needed and said we certainly would want to respond to the President and hoped we'd have this hearing this morning and that we would welcome his representative to tell us what we need in this case of this particular emergency and to join us in this general subject. But no one has come. We have heard no communication. There has been silence about the program, which is disheartening but not the first time. This committee has been here a very long while, and the Corps of Engineers, from which we will hear, has been here even longer than this committee and longer, indeed, than this Congress, so let's get to work.

We are very pleased that we have mustered a Monday morning quorum, as these things go. First of all, to our dear friend and colleague, Senator Reid, we welcome you, sir, and we'd like to hear any remarks you have.

OPENING STATEMENT OF HON. HARRY REID, U.S. SENATOR FROM THE STATE OF NEVADA

Senator Reid. Mr. Chairman, I appreciate you holding this hearing. I think it is also important for someone that is on the committee to remind posterity, at least, of the fact that you have, for many long years, talked about the importance of doing something about infrastructure. As you have indicated, certainly this earthquake points up the importance of your continually talking about the need to do something about the deteriorating infrastructure of our country.

We really are fortunate—and I think the evidence will hold this to be a fact—that California was as well prepared as they were. But for that section of freeway, the loss of life would be minimal.

So that notwithstanding, we have significant work to do throughout this country on doing something about our infrastructure. So I do, again, thank you for holding this hearing on the earthquake that struck the Bay Area on the 17th of this month.

In addition to providing members of this committee with information about the California earthquake, I hope, Mr. Chairman, we will also learn what the Federal Government is doing to mitigate the effects of future earthquakes in California, as well as in other States.

For example, my being from Nevada, I have particular interest in this information. Nevada, which is the fastest-growing State in the Union, is often overlooked in favor of our big brother to the west, California, and rightfully so. They are a State of some 28 million people. We are a State of less than two million people. Most Nevadans don't usually mind this arrangement until the issues directly involved are health, safety, and quality of life. And the danger of earthquakes is one of those overlooked issues.

Nevada lies in one of the most seismically active regions in the Nation. There is an average of one major trembler measuring more than six on the Richter scale every 27 years since the mid-1800s when we became a State. In 1954 alone, four quakes measuring between 6.6 and 7.2 on the Richter scale caused significant damage in LaHunt Valley, an area just a few miles east of Reno.

An engineering geologist for the Nevada Bureau of Mines has said, "We should anticipate another major earthquake in Western Nevada in the near future." A big quake could hit Nevada at any time. Little attention is focused on this fact because the larger earthquakes have occurred in the less populated regions of the State—areas laced with literally thousands of fault lines. And the public should know, Mr. Chairman, the proposed high level nuclear waste repository sits right on one of these faults.

The State of Nevada's scientists have raised concerns in the past about the suitability of licensing the proposed high-level waste repository on Yucca Mountain, less than 100 miles from Las Vegas. Even Department of Energy scientists have questioned the wisdom of the site.

In a report finalized in December of 1987 and reported just recently, DOE geologist Jerry Simanski states that Yucca Mountain may be "approaching conditions that will result in major fault movement and a rapid rise in groundwater perhaps to a level at or above that of DOE's repository horizon."

His earlier statements, Mr. Chairman, were speculation. But with the quake that just occurred in the San Francisco area, this is no longer speculation. The repository could become fractured and flooded during the next few years—and certainly within the next 10,000 years that are set for safety for the site area. This, of course, would lead to a loss of waste isolation.

Future pressures beneath Yucca Mountain could force water into the storage caverns through cracks in the rocks. In other words, water could eat away at the canisters, allowing the release of deadly waste.

This site should concern Congress for other reasons, as well. What if nuclear waste were being shipped on an interstate highway? For example, there is nuclear waste that is produced in the northwestern part of the United States, and it likely could have been coming over the area of the roads that had so much damage at the earthquake.

Senator **Moynihan**. That's right, Harry.

Senator **Reid**. That's very true. Imagine the magnitude of the disaster if nuclear waste shipments were crushed under the tons of steel and concrete.

Finally, Mr. Chairman, how can we expect FEMA to address these contingencies? There are a lot of things that I don't know and haven't had experience in, but experience with FEMA goes back to when I served in the House and served on the Science and Technology Committee. Senator Gore at that time was chairman of a subcommittee in the House, and we held many hearings on FEMA. After that, there were the floods in the Colorado River again we dealt with FEMA. There was the PepCon explosion in Nevada where we dealt with FEMA. I also heard some complaints about how FEMA was handling Hugo. I relate back to times when we were getting nothing but political responses from FEMA when we had an explosion in Nevada that caused loss of life and property damage.

Senator MOYNIHAN. Yes, yes.

Senator REID. So I think it is time to take a real close look at FEMA. Now, part of it is our fault. FEMA reports to 20 subcommittees of this Congress. How can any agency do a decent job when they are required to report to 20 subcommittees? They can't. And so even though we share the responsibility, it is not simply our fault. They have to get their act together—their political act.

So I would hope that we will learn more from FEMA as to how they are going to handle this disaster that took place and the many other areas that the chairman has outlined for the hearing here today. I look forward to the hearing.

Senator MOYNIHAN. One thing we can say with certainty is that while the State of Nevada may not get quite the attention the State of California gets, generally speaking, on this subcommittee and the Committee on Environment and Public Works, Nevada comes very first and it is quite a while before we can get to California. You have to cross Nevada to get to California here while Harry Reid is on this committee.

Speak of the far west, our distinguished ranking member of the subcommittee, we very much welcome Senator Symms this morning. We were just on the floor discussing this last bit of business on Friday.

Senator SYMMS. Thank you, Mr. Chairman. I note that the chairman has been discussing this. On Sunday I turned on my television set, and lo and behold there was my chairman discussing the earthquake. I thought "Where am I? Back on the Senate floor?" Then I said, "No, he is on CBS."

Senator MOYNIHAN. No, I'm going to have to be firm about that. It was NBC.

Senator SYMMS. On NBC, Meet the Press.

Senator MOYNIHAN. It has been 24 years since the first time I was on Meet the Press, and I do remember.

OPENING STATEMENT OF HON. STEVE SYMMS, U.S. SENATOR FROM THE STATE OF IDAHO

Senator SYMMS. It was Meet the Press. Excuse me.

But, at any rate, I am pleased to be here this morning, Mr. Chairman. We have several of our colleagues—Senator Warner and Senator Chafee—that had requested that this meeting be tomorrow so they could be here. They simply couldn't get their schedules changed. I'm particularly pleased to see Senator Wilson here who, incidentally, if my understanding is correct, was in San Francisco during the quake and experienced this awesome event. I know that he cancelled a very important day of meetings in San Francisco with SBA officials to discuss some of the ramifications and the implementation of some programs through SBA that might be helpful to California constituents but flew last night so he could be here with us. I certainly appreciate that.

I might say, Mr. Chairman, that I feel a personal interest in this for many reasons. My nephew was on the 34th floor of a skyscraper, and he thought it was going to tip over. He said it was the most frightening experience he had been through. But I had to laugh because he was educated in the west and then went to Harvard Business School and chose to go back to San Francisco to work there, so we were kidding him within the family not to come crying about it because he chose to move there. He had only been on the job for a week. So he got a real indoctrination in San Francisco.

Senator REID. That's what happens to your judgment when you go to Harvard.

Senator SYMMS. Right. At least he didn't go to Harvard and turn left.

Anyway, Mr. Chairman, I am delighted that we are having this important hearing. I hope that it will lead to the expeditious passage of legislation which will be needed very soon to waive the $100 million cap on emergency relief funds so that California officials can begin repairs in San Francisco and the Bay Area with the assurance that their expenditures will be reimbursed appropriately.

We welcome you here, Senator Wilson. I might say that in addition to you and I, we were joined by: Senator Burdick, the chairman of this committee; our ranking minority member, Senator Chafee; and Senator Dole on introducing S. 1775, a bill to waive the cap on emergency relief, making the Oakland Bay Bridge eligible for Federal aid highway funds. There may have been other Senators sponsoring the legislation. I don't know. We left it open for sponsorship. There may have been more as the day progressed.

But S. 1775 provides sums as may be necessary to repair and reconstruct the Bay Area highways damaged in the earthquake. I hope the committee will quickly adopt either this or some other similar legislation. I would also note that a continuing resolution providing relief aid for California was introduced in the House last Friday and, according to press accounts, the House will act on the legislation today.

Our subcommittee chairman had that resolution printed in the Congressional Record on Friday, and Members should take note of its provisions. It provides a total of approximately $3 billion in FEMA, SBA, Highway, and other Federal aid. About $1 billion of the amount comes out of the Highway Trust Fund.

I'd like to say, Mr. Chairman, that I do not necessarily oppose the House legislation, although I would like to know more precisely what the cost will be before appropriating such substantial funding. To my mind, it is preferable to provide such sums as may be necessary at least for the highway work to ensure that California is neither overpaid nor underpaid for the cost of those highway repairs. I do not believe that trust fund dollars should be used for the reconstruction of facilities other than highways and bridges, and the authorization of these emergency funds should not be used as a means to hammer Congress into either a fuel or a general tax increase.

There exists a cash balance of approximately $10 billion in the highway account of the Trust Fund, and there is plenty of room for additional spending in the highway program before the Byrd Amendment would require an automatic reduction in the overall highway program. Of course, the cash balance in this and other trust funds is being used to hide part of the Federal deficit, and the substantial new outlays from the Highway Trust Fund may require cuts in accounts funded out the general fund. But to my mind that is only an argument for a more honest budgeting from the start so that we commit dollars that are paid by the taxpayers for highways and bridges to highways and bridges and not allow them to be hidden in a general, unified budget for other expenditures.

I thought the chairman asked a very good question on the Senate floor, which was, "How is it that a 60-story skyscraper survived in this event in California with no damage of any kind and a two-story highway collapsed?" I think it is a good question. The correct answer, if acted upon, will save money and, more importantly, it will save lives.

So I take this opportunity to remind those who may be viewing this hearing that while engineering advances may help prevent damage from earthquakes, there is very little that government or any human institution can do to prevent the quakes, themselves.

Now, news accounts indicate that this is a matter of some confusion for the people, but I do think that it should be said that the earthquake is not the President's fault, not the vice-president's fault, not the mayor of San Francisco's fault. The fault existed long before any of those people mentioned——

Senator MOYNIHAN. You're saying it is San Andreas' fault?

Senator SYMMS. Right. San Andreas' fault. You are correct.

Senator WILSON. If ever I heard a straight line, Mr. Chairman, that was it.

Senator MOYNIHAN. Right.

Senator SYMMS. So on that note, Senator Wilson, we welcome you here to the committee straight from the San Andreas fault. We know it is not your fault either, Senator Wilson, but I am anxious to visit with you personally to hear what it feels like to be in that kind of an awesome earthquake.

Senator MOYNIHAN. In welcoming Senator Wilson, let me make one point which I hope we will be very disciplined about in this hearing and in the whole response to Hurricane Hugo and to the most recent earthquake in California and to the kinds of events that Senator Reid mentioned, which is that we have to find funds, we have to find resources, and we do not now have them.

There is, I must insist, no cash balance in the Highway Trust Fund whatever. There are $12 billion worth of Treasury obligations—which is to say the Treasury owes the trust fund. There is a small emergency account in the Federal Highway Administration which can be drawn on any time. They can write checks, and there are appropriated monies for them. If we are going to do what we have to do, we are going to have to find new revenues.

Now, we can borrow more money, as we have been borrowing against the future in the form of running down our capital structure. Or we can raise revenues. I said yesterday on Meet the Press that I thought this was a time to address the subject of the gasoline tax.

In constant terms, the price of a gallon of gasoline today is one half what it was 10 years ago. If we want to think of a user tax for highways, it seems to me an appropriate one. I don't insist that it is the only one, obviously, but if you think we can respond to this emergency without finding revenues, I think that's wrong. The money can be gotten two ways: we can pay for it now, or we can have our grandchildren pay for it by borrowing. That is the issue, or so at least I think.

Last Friday we received a very fine letter from Senator Wilson addressed to the two of us—I think you have a copy—asking that we not only attend to the immediate questions raised by the earthquake, but to the larger issues of construction technologies and the integrity of our Nation's infrastructure and the safety of the general public during times of severe physical challenges such as earthquake, hurricanes, tornados, and floods.

I want to make it clear that this hearing is addressed to the subject of St. Croix and Puerto Rico and South Carolina as well, of course, as California.

I want to put this letter in the record, noting, as Senator Wilson does, that the Bay Bridge was built in 1936 and the Nimitz Freeway was designed—it would have had to have been designed in the mid 1940s. Construction began in 1949. I think that's the answer to your question about why the TransAmerica Building, which is 49 stories, is fine and the Nimitz is down. We lived and we learned. The question is: are we now going to be able to do something with what we learned? That is what we are here for this morning.

Finally, Senator, we welcome you. We thank you for coming back. We know what a concern this is to you, and we look forward to your testimony.

Senator REID. Mr. Chairman.

Senator MOYNIHAN. Yes.

Senator REID. Just one brief thing. Senator Wilson, I wonder if in your comments you would direct some attention to Governor Dick Deukmejian's call for taxes. I think he talked about a gasoline tax on a State-wide basis, but that is unclear. If you know, I'd ask you to direct some attention to that point.

Senator MOYNIHAN. I will place your letter in the record. You may proceed exactly as you wish.

[The letter referred to follows:]

PETE WILSON
CALIFORNIA

COMMITTEES:
ARMED SERVICES
AGRICULTURE, NUTRITION, AND FORESTRY
GOVERNMENTAL AFFAIRS
SPECIAL COMMITTEE ON AGING
JOINT ECONOMIC COMMITTEE

United States Senate
WASHINGTON, DC 20510

October 19, 1989

The Honorable Daniel Patrick Moynihan
Chairman
Subcommittee on Water Resources, Transportation,
and Infrastructure
458 Dirksen Senate Office Building
Washington, D.C. 20510

The Honorable Steve D. Symms
Ranking Minority Member
Subcommittee on Water Resources, Transportation,
and Infrastructure
458 Dirksen Senate Office Building
Washington, D.C. 20510

Dear Senator Moynihan and Senator Symms:

I want to thank you in advance for your cooperation in ensuring that the State of California receives all possible federal aid as quickly as possible in its attempt to mitigate the severe and almost unbelievable damage caused by the earthquake two days ago. For example, we all recognize that the need for legislation to amend current federal highway emergency relief statutes is immediate.

At the same time, questions surround the construction and maintenance of both I-880 (the Nimitz Freeway) and the San Francisco-Oakland Bay Bridge need to be answered. We have all heard news reports quoting local and State officials as saying that they expected both the Nimitz and the Bay Bridge to survive such an earthquake intact. As the Bridge was constructed in 1936, and the Nimitz during the 1950's, it was incumbent that local, State, and federal highway officials continually monitor developments in anti-earthquake construction technologies and implement any and all such technologies to prevent the type of disaster we have just witnessed.

As a result, after the Senate completes what I hope will be its initial response to the State of California in the form of additional Federal-aid highway funds and FEMA expenditures, I strongly urge the Subcommittee to hold a hearing, or series of hearings, on the subject of construction technologies in the transportation industry, including the construction of highways, bridges, tunnels, utility connections, and other structures whose integrity must not be compromised due to a natural disaster. Questions regarding the federal safety certification process should be a conspicuous part of the hearing as the Subcommittee explores how best to ensure the integrity of our Nation's infrastructure and the safety of the general public during times of severe physical challenges such as earthquakes, hurricanes, tornadoes, and floods.

Obviously, the Senate must work quickly to help the Bay Area get back on its feet. In the long term, however, for the sake of California and the Nation, the Congress must take a hard look at federal disaster programs, including programs designed to avoid disasters such as the terrible wreckage of I-880 and the Bay Bridge. I hope that your Subcommittee can take the lead on both counts.

Thank you very much for your consideration in this request.

Sincerely,

Pete Wilson

PETE WILSON

cc: The Honorable Quentin N. Burdick
The Honorable John H. Chafee

PW:lg

STATEMENT OF HON. PETE WILSON, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Senator WILSON. Thank you very much, Mr. Chairman.

Gentlemen, I am not just pleased to be here this morning, I am grateful. I am grateful both because of the promptness with which this hearing is occurring, and grateful to be here, literally. At the time of the quake, I was on the 13th floor of a hotel in downtown San Francisco. I should say to Senator Reid that he may now be wrong about the populations of his State and mine. Mine now may be 25 million and yours may be 5 million.

I don't think that has actually happened. In fact, one of the really magnificent stories to come out of this whole tragic experience has been the response of the people—not only the professionals on the governmental staffs at all levels. A truly inspiring chapter has been written in volunteerism in this country by the response of people who came instantly, who manned all night the Red Cross shelters, who came from as far away as the Napa Valley. That was in the first few hours.

Perhaps the most dramatic thing that has happened in the wake of the tragedy is that someone has been found alive. He was pulled from the rubble after almost four days by an Orange County firefighter—a volunteer who had gone to San Francisco in order to be of what assistance he could.

The police, the firefighters, and the physicians have truly been inspiring. It is a terrible but wonderful story that a young physician, crawling through space that was barely large enough to allow him movement, was able to free a child, but he was compelled to do so only after he was successful in cutting through the child's dead mother with a chainsaw, and then was required to amputate the child's foot. A grim rescue, one in which this man's courage, as well as his skill, I think should be noted for the record. I might note, as well, that he is a very selfless young man. Actually, there was a pair of these young physicians. They had time to give credit to everyone else and to take little for themselves.

Mr. Chairman, when the quake hit it was clearly going to be a different experience than I had had before. As a Californian, we are used to living with tremors. My first experience was in a law school classroom some years ago, and I noticed that I was considerably more agitated than the native Californians around me, and I came to understand why. But this quake—I think Mr. Reid will be interested, in light of his opening statement—registered seven on the Richter scale. As he put it, the wonder really is that the damage was not greater. That in no way depreciates the tragedy and the loss of life and the suffering of those who survived or those who were killed in that quake. But it is a fact that in the city of San Francisco the profession of architecture has had a resounding vindication.

I have always had admiration for those in the profession—never more so than in the wake of this tragedy. Because with the exception of a brick wall of some vintage which did crumble and took six lives in the center of the city, it was only in the marina—that area built upon fill that was provided during the 1915 exposition—that real home destruction occurred. What happened there, Mr. Chairman, is that the soil beneath the foundations of these three- and four-story homes and apartment buildings in some cases simply liquified. Literally, the foundations were shaken from beneath these homes and what were four-story homes in an instant became one-story homes.

There is obviously damage of two kinds: the damage to structures and the damage to the people. And while we are concerned here with infrastructure, let me say that much has been made this morning of the need for prompt response by FEMA. I heartily echo that. There is an urgent need for help for people now. I must say that FEMA arrived quickly. In fairness, FEMA has been stretched very thin by the tragedy in South Carolina.

Senator MOYNIHAN. And Puerto Rico and St. Croix.

Senator WILSON. Yes, sir. That's correct.

Senator MOYNIHAN. They are Americans, too, you know.

Senator WILSON. Most of the regulars from FEMA are down in Puerto Rico and St. Croix and South Carolina. I was advised on Friday that some 500 personnel from FEMA would be flown in, that some who were new would be given training on Saturday, and they hoped to have the centers open on Sunday. That is the kind of prompt response that is enormously appreciated.

I would be remiss, Mr. Chairman, if I did not point out the fact that the epicenter occurred, if you are familiar with the geography of the Bay Area, close to the city of Watsonville. That is south of the Bay. The areas which received the most devastation were the cities of Santa Cruz and Los Gatos. I think that is worthy of our attention because downtown Santa Cruz contains some very old buildings, some at least a century old, some that preceded the most severe earthquake in the history of the century, that which is estimated to have registered—if there had been a Richter scale—8.3 on it. That was the terrible and famous quake of 1906.

But there was very great devastation in Santa Cruz and very great devastation in Los Gatos, not just of buildings, but to gas mains and to water mains. And, of course, the tragic fire that consumed about a quarter of a block and took seven lives in the marine area of San Francisco is believed to have been ignited by sparks that ignited gas escaping from a broken main.

Let me just say that one of the suggestions which I have made to the associate director of FEMA, Mr. Peterson, was that, given the potential shortage in trained personnel, and given one of the things which I think we need to look at as perhaps a congressionally imposed good intention that has stood in the way of more prompt response, are the requirements for verification. It was my suggestion to him that he used the skilled personnel available from building inspection staffs of cities and counties. These are people who are trained specially in the arts and science of structural integrity. They are also able to be, in effect, assessors and appraisers.

But at the very least it seems to me that we ought to look at the law and see if verification is not something that can be a three-step procedure: one, photographing the damage; two, preparing it; three, being concerned with whether or not there has been overpayment. But in this regard, it seems to me that one FEMA employee might be able to deputize and oversee some six city employees and greatly expedite the work. It might be something that would be worth considering as a standard operating procedure, because in every instance those personnel will be available and they, of course, will remain in the community after FEMA has departed. They know the people. They know the area. It seems to me that they can be of considerable assistance.

For the most part, the public's attention has revolved around the two transportation structures whose collapse symbolized the quake's devastation—the Bay Bridge and the unbelievable mile and a quarter segment of the Nimitz Freeway, Interstate 880.

When I first saw that, I said, "My God, I don't believe it." It has to be seen to be believed.

When I was travelling last week with President Bush, Vice President Quayle, Secretary Skinner, and Governor Deukmejian I heard essentially my own sentiments echoed. When the governor saw it he said, "My God," and was speechless thereafter. The President saw it first from the air and then travelled to it on the ground. When you see it at close hand it is truly a vision that defies understanding. What had been a 20-foot interval between the layers to accommodate truck traffic is now less than 20 inches and, in many places, there is virtually no separation. It is virtually one concrete ribbon laid on top of another. It is a wonder that the survivor, this 57-year old stevedore, survived at all—that anything could survive at that.

The point which Mr. Reid made is, I think, a very telling one. So far as we know, there were only passenger vehicles. At one time it was feared that a transit district bus was trapped. But there was no gasoline truck. There was no truck hauling toxic or hazardous waste of any kind, but there might have been.

And, indeed, I think you are correct, Mr. Chairman, in pointing out that the difference between the TransAmerica building and all these modern skyscrapers is that they are built to withstand earthquakes, and the state of the art in 1949 was obviously considerably different. I couldn't help observing, as I walked the length of that segment, that at one point the piers that supported the upper deck had all broken out at a 45-degree angle just like matches from a paper matchbook that someone had splayed out turning the matchbook upside down. What had happened is that they had given way at the base and then splayed out as the upper deck fell to the lower one.

What was also rather apparent, even to a layman, was that the reinforcing steel had, in most cases, extended beyond that pier a very brief interval into the concrete below, and it had pulled loose. I am told that the state of the art today is that those reinforcing rods are butt-welded so that there is a continuum of reinforcement running the entire length of that column.

Senator Moynihan. I wonder if I could just interject to say—I'm sure Senator Wilson knows this, but perhaps not everyone—that Professor Richter was a professor at Stanford, 20 miles away from this event. His great work was published in 1941. It would not really have gotten into the engineering profession by 1947 when they began to design what we call the Nimitz Freeway. This whole science is new. Nobody knew what earthquakes were. They used to think—and probably still do in many places—that the gods got angry and that's what happened. And then we learned about tectonic plates. Well, it is not as interesting as the gods getting angry, but it is a little more predictable. And I don't think Richter had even developed his scale by then. That came later. So we're learning. And, to be clear, we are at the beginning of this understanding.

Senator WILSON. Mr. Chairman, that is true. And yet, in the interval, there has been enormous progress.

Senator MOYNIHAN. We have learned a lot.

Senator WILSON. As witness the fact that those skyscrapers are still standing.

I had the opportunity to observe an identical scar that appeared in the plaster on a column that descended the length of the stairwell which my wife and I descended. I got to see the same scar 13 times. I was on the 13th floor. But, notwithstanding the crack in that plaster from a very good wrenching, the building, itself, remained. The buildings in Santa Cruz did not.

Ironically, since you mentioned the affiliation of Professor Richter in Stanford, several buildings there were weakened. They estimate $160 million worth of damage.

Senator REID. Is that in San Francisco, the $160 million?

Senator WILSON. No, no. At Stanford in Palo Alto.

One of the early success stories of FEMA, by the way, is that a casualty of the quake was the Veterans' Hospital in Palo Alto and the wing, in particular, that housed an ongoing project in which between 150 and 200 Alzheimer's patients were being treated and monitored and studied. I understand that through the efforts of FEMA and the Department of Veterans' Affairs they are lodged and, in fact, the very important work, in a singularly important joint venture between NIH, Stanford, and the Department of Veterans' Affairs, is continuing.

But the collapse of Route 880, I must tell you, is something that does have to be seen to be believed. And even then it is difficult to comprehend the full tragedy. What we do know is that the loss of life will be less than was initially anticipated. Bear in mind the quake occurred at 5:04 p.m. Ordinarily, there is bumper-to-bumper traffic in that segment of the freeway. It is by God's grace that a number of sports fans had gone home to witness the beginning of the third game of the World Series and therefore it is at least speculated—and we will not know until, in fact, the area has been cleared, precisely how many people did lose their lives there. I can tell you that the Oakland Police Department had received, by Wednesday morning, 110 missing person's reports, which was substantially less than the 250 that initially were estimated to be casualties.

Senator MOYNIHAN. That's good.

Senator WILSON. What has not been discussed to any great extent by the media, though I have spoken with Federal, State, and local officials about it, is the viability of the Bay Area's transportation infrastructure exclusive of the panel that fell on Bay Bridge and the collapse of the mile and a quarter segment of the Nimitz.

Clearly, both the Federal Department of Transportation and FEMA will be called upon to aid scores, if not hundreds, of roads throughout the Bay Area from Santa Cruz to the East Bay.

Now let me turn to the legislation that Senator Symms introduced on behalf of myself and Senators Burdick, Chafee, and Dole, S. 1775. I do want to stress, as Senator Symms stressed on the Senate floor at the time of the bill's introduction, that this legislation is a working document, a first effort to utilize the subcommittee's expertise in the area of making necessary repairs to infrastructure. The bill, though necessarily preliminary, I think is a very useful beginning.

It accomplishes several important goals, one of which has been noted here this morning by Senator Symms. It lifts the $100 million per disaster cap on emergency relief funding and authorizes the Secretary to expend such sums as are necessary to rebuild the affected infrastructure, and it holds California harmless in ensuring that emergency relief funds to not apply as an offset to the 85 percent minimum allocation.

Passage of these provisions is essential to ensure that California's damaged infrastructure will be repaired as quickly and as efficiently as possible. However, there are two notable deficiencies in the bill. First, the bill makes no change in the current law, which forces such emergency repairs to be completed within 90 days in order for the State to receive 100 percent Federal reimbursement for those repairs.

Mr. Chairman, I needn't belabor the obvious. That segment of the Nimitz freeway——

Senator Moynihan. It's not going to be repaired in 90 days.

Senator Wilson. Not in 90 days and not in 360 days.

Senator Moynihan. Point taken.

Senator Wilson. Clearly there is no way that the State and the local public works personnel can make whole again the devastating effects of the earthquake that quickly. Not even a full assessment of the damage and its cost has been completed at this time. Indeed, an accurate assessment may involve weeks. That relates purely to the freeway and to the bridge, which are, I think, easier to assess than the road damage throughout that entire region.

Second, while the bill allows the Secretary to expend funds to repair the Bay Bridge, funds for which the bridge may not be eligible under current law because it is a toll bridge and——

Senator Moynihan. That is an old policy of the National Government, and we will obviously want to revisit it.

Senator Wilson. The bill does limit such reimbursement to the difference between the bridge's insurance repayment and the actual cost of repair. I have discovered, since speaking with him, in conversations with my long-time friend and former brother mayor, Congressman Mineta, who has your responsibility in the House, that what the State has insured is not the bridge structure, itself, but the toll receipts. To further complicate the matter, those bridge toll revenues ordinarily are shared by local Bay Area transportation projects. Therefore, not only does the State not carry structural damage insurance for the bridge, but any change in the toll payment will, in fact, affect the other portions of the Bay Area transportation infrastructure at the very time when all Bay Area transportation modes and projects need as much help as they can get.

In that regard, I am compelled to note that because of the closure of the Bay Bridge it obviously will fall upon the other bridges—the San Rafael Richmond Bridge to the north and the San Mateo Bridge and Dunbarton Bridges to the south—to absorb that normal traffic that would ordinarily cross the Oakland Bay Bridge. And in order to see to it that the increased traffic is not caused undue delays each day, the governor has suspended tolls on those bridges that still collect them. That will result in a further diminution in the revenues that would ordinarily find their way into financing needed maintenance and repair of Bay Area roads and transportation infrastructure.

The House Appropriations Committee will, as you have noted, this afternoon mark up a transportation funding bill which will include $1 billion for such repair and reconstruction, and will extend the 90-day period to 180 days, and will make Bay Bridge repairs eligible for full reimbursement.

Mr. Chairman, I look forward to working with you, with Senator Symms, and with all the committee members.

Let me now respond to Mr. Reid's inquiry as to what the State intends.

If they are proceeding as they indicated they intended to do, the Governor and the Legislature will have convened a special session of the Legislature for the purpose of dealing with both the tragedy and the necessity for repairing and restoring the damaged infrastructure. What they will do, Mr. Reid, I cannot say precisely. I don't think at this stage they have come to consensus upon it. There is precedent for temporary taxes to deal with precisely this kind of——

Senator MOYNIHAN. Temporary taxes?

Senator WILSON. Temporary taxes. And, in fact, one existed for three years, one for about a year. They were, in one case, sales taxes. But it seems to me that the most obvious sources of revenue for this kind of repair are gasoline taxes and, if necessary, some local sales taxes. But I think that there is obviously going to be a tremendous necessity here.

We are looking at a freeway which is going to take a long time to clear, a long time to rebuild. And, indeed, the preliminary assessments are that the entire structure of the Nimitz Freeway, including that that remains standing, may, itself, have to be replaced.

The state of the art, I am told, has changed. Stories in the California newspapers over the weekend indicate that is the case. There does seem to be a division of professional opinion in that regard, but I am told by those in the construction industry that the techniques have changed.

Mr. Chairman, I would be happy to answer any questions that you or the members of the committee may have. I am grateful for the attention that you are giving this, because the people in the Bay Area I think are entitled to as prompt response as we can give them.

Senator MOYNIHAN. We are very grateful for you for taking the red-eye back to be here. We don't want to keep you longer.

General Kelly is going to testify to that point you made about what the engineers are picking up on.

Let me just press you a little bit to get your advice. You have mentioned that you are going to have to raise taxes temporarily in California. I suppose there is a way around proposition 13. In any event, I gather you are going to revisit that subject next June. But gasoline taxes, as you said, sir, and as Governor Deukmejian has said, to use the tax is a very direct connection between what you pay and what you get. You can see what you get, which is one of the reasons we have an interstate system.

I made the point earlier, not that we take any joy in doing this, but if we are going to keep the system of roads and bridges that we have inherited and have built, we are going to have to pay for that just as we paid to build them in the first place. Now, we can do it by borrowing and letting our grandchildren pay, or collecting revenues to pay as you go. That's not a dishonorable principle. Pay as you go—that's what President Eisenhower put in place—not charge your grandchildren. Remember, if we do not raise revenues for this, sir, and my fellow Senators, we are going to borrow money from the Japanese and let our grandchildren pay. That is exactly, literally what will happen.

Now, today we have hidden numbers. In constant dollars, the gasoline was $1.395 a gallon at the beginning of this decade in 1981. It is 73.9 cents a gallon today. Gasoline was twice as expensive at the beginning of the decade as it is now. Gasoline in Canada—and I would like to look at Canada to see how they are doing—is $1.54 a gallon. That's exactly twice ours. They have just as much oil as we do—everything we have. Only they are paying their way. They are not going to charge their grandchildren.

I know this is not something we're supposed to say, and I can understand that nobody from the Administration is present to hear it, and I don't expect anybody will be—we are still to hear from the Administration from this event. Photographs have been taken, and I suppose, therefore, the event is over. Well, it is not.

Senator WILSON. Mr. Chairman, in fairness I would have to say that the Secretary of Transportation, himself, has been out there, and without much sleep, I know, because I greeted him at 3:00 in the morning.

Senator MOYNIHAN. They haven't been here, sir. That's our problem.

Senator Reid.

Senator REID. Thank you, Mr. Chairman.

The concept that we tend to overlook, Senator Wilson and members of the committee, is that we have a system of national roads and highways. The fact that your roads are messed up in California affects me in Nevada. We have a lot of commerce with the State of California, and the fact that people can't travel in California means they can't travel to and from Nevada, and it applies all over the country. So this is really a national problem. It is not only California's problem. I think that it is important that we get that point across.

I have heard TV commentators say California is a big State and they should be able to handle this problem on their own. But the point of the matter is that your problems are my problems when it comes to transportation, and I think we have to keep stressing that point. This is not California's problem; it is all of our problem.

The other question—I don't know, and I'm sure we will have some experts that can talk to us about this. You served in local government, and so did I. One of the biggest pains was building codes. We got all kinds of complaints like, "Why do I have to do this? It is so silly that I have to do this. Why do they have these stupid laws?"

Well, I think what went on in California is an example of why we have those building codes. But for the stringent building codes that California has, which are some of the most stringent in the entire world, it costs a lot to build in California. One of the reasons is their building codes. Here is an example why you have stringent building codes. It causes less property damage, less personal injury, and less loss of life.

I think we should also give California some credit for that, because I think it is a result of some of these low-level bureaucrats enforcing these stringent building codes that we had not the significant loss of life that would have remained.

Pete, do you know what will happen in areas like the Marina area that was built on this landfill? What are they going to do there?

Senator WILSON. Senator Reid, I do not know. I think that the mayor and board of supervisors of the city of San Francisco are going to be faced with a very difficult decision—an agonizing decision—because there are houses that were destroyed and, next to them, houses that appeared to be unfazed. It will require someone who is a soil and structural engineer to explain that. I cannot.

But what is clear is that a great many people have homes there and one of the great difficulties that Mayor Agnos encountered was a mob which he described as hostile, and I think perhaps he did not exaggerate. A hostile crowd of citizens who were understandably frustrated because they could not return to their homes because the police and firefighters would not allow them. People whose homes had been destroyed were at their wits end trying to get into salvage cherished belongings and photographs, and they were not permitted to enter for reasons that were obvious.

I don't know the answer to your question. I will say, though, that I think that they have to consider very, very carefully whether or not it is safe to permit people to continue there at the very least without some kind of major changes to those structures, because it is fill and it is fill that behaved very differently in different spots. In those areas where damage was done, the soil seems to have simply liquified right beneath the foundation.

Let me respond to your point, though, if I may, about this being a problem that affects your State and others, as well. You are absolutely correct. I was just handed a note that confirms your judgment. It states that the Port of Oakland last year handled 15 percent of the entirety of imports to the United States. It is very difficult to get to the Port of Oakland without Interstate 880. So there is going to be a very real economic dislocation.

Another dislocation of the kind is that which I mentioned that will divert the traffic that used to flow over the Bay Bridge to the other bridges, occasioning a much greater load on them and also a much greater load on BART—the Bay Area Rapid Transit—which runs along the East Bay from Oakland to San Francisco, as a result of the closure of the bridge during the period that it is closed. That could be a month or it could be six weeks, because it isn't simply the segment that fell that has to be repaired. They fear the real damage is to the underpinning to the tower that supports that entire section.

That obviously means, as they run the extra trains, that there will be extra hours that will add up to extra wages. I am informed that the estimated increase in the weekly cost of operation for BART until the Bay Bridge is in operation will run about $755,000.

Senator **Moynihan**. Thank you, Senator.

Senator **Reid**. I have just one more comment, Senator Moynihan. California's gasoline and diesel tax is nine cents. Take, for example, the State of Nevada, which is next door, at 18 cents. The national average is 15 cents. So I think Governor Deukmejian is on the right track. He recognizes that California, being a State that is in the top ten as far as per capita income, is really in the very bottom tier as far as State gasoline and diesel tax, so he is looking in the right direction.

Senator **Moynihan**. I think the U.S. average is 15 cents.

Senator **Reid**. That's what I said.

Senator **Moynihan**. So if California is going to get its share and more of Federal monies, it ought to have at least its share of local monies.

Senator Symms.

Senator **Wilson**. Mr. Chairman, might I respond to that point raised by Senator Reid?

Senator **Moynihan**. Of course.

Senator **Wilson**. Your point is very timely. It is topical. Before the earthquake occurred, we were faced with, very frankly, a real backlog in terms of infrastructure projects—highway projects, the need to expand both highway and fixed guideway transportation. The Governor and the Legislature, in one of the more productive sessions that they have had, succeeded in placing on the ballot for next year a nine cent increase on the gas tax, and an increase in truck weight fees. The concern that we had all had, those of us who are fervently supporting that which would raise about $15.8 billion over a period of a decade, is that the early polling showed that there was public support for five cent increase in the gas tax, but not for nine. I would hope that the necessity for nine now becomes more apparent because there is a need that didn't exist before.

Senator **Reid**. Is that the only way it could be raised, with a vote of the people? Legislature couldn't do it alone?

Senator **Wilson**. It requires a vote of the—well, it could have been raised by the Legislature, alone, but the vote of the people was thought advisable because a vote of the people is required in order to not just raise the money but to spend it. There is a Constitutional spending limit, and in order to——

Senator **Moynihan**. Is that proposition 13?

Senator **Wilson**. No. That is not proposition 13. That was proposition 4, the Gann spending law.

Senator **Moynihan**. The Gann?

Senator **Wilson**. Yes. And that has to be changed in order to permit the expenditure of the funds, even if you imposed the tax.

Senator **Reid**. Thank you, Mr. Chairman.

Senator **Moynihan**. Thank you, Senator.

Senator Symms.

Senator SYMMS. Thank you very much, Mr. Chairman. I will not delay Senator Wilson. I do just want to make a couple of comments.

I noticed, looking at the witness list, that General Kelly from the Corps of Engineers will be testifying, and Tom Larson from the Federal Highway Administration.

Senator MOYNIHAN. Right.

Senator SYMMS. So I look forward to what they have to say.

I want to thank you, Senator Wilson, for your comments and for your interest and your willingness to work with this committee. I think you'll find that we will be willing to work with you to try to help people that are in the Bay area.

But I just want to note for the record, Mr. Chairman, that it is possible—and I think it is a question I'd like to entertain to Tom Larson, and I'll do it in advance so he might speak to it. I understand that we could run a Federal highway program of $19 billion a year. Our current program is somewhere around $13.1 billion, I believe. We could run a $19 billion per year Federal highway program without breaking the Byrd Amendment, not raising fuel taxes, and that would be spending in the neighborhood of $5 to $6 billion a year more for roads and infrastructure without raising taxes.

The problem has been that in the Congress, as well as the Administration, the willingness to provide a priority for infrastructure spending has not been there. It isn't that we haven't taxed people enough to do it; we have not spent the money. We spend the money on all kinds of things.

I'll cite for an example that just recently we spent over $2 billion on a drug program without raising taxes. We're going to take it out of other programs. And the same thing is true of highways. We tax the American people to build roads and bridges, and then we don't spend the money on the roads and bridges.

As one Senator, I'm not going to be very enthusiastic about raising fuel taxes as long as we don't spend what we already have raised.

I agree with the Chairman that the money is not really in the trust fund because it is an illusionary bookkeeping procedure. We spend the money on National Endowment for the Arts, on F-15s, on whatever thing you can think——

Senator MOYNIHAN. F-15s?

What did you just say?

Senator SYMMS. It is spent on other projects.

Senator MOYNIHAN. Steve Symms——

Senator SYMMS. It is spent on other projects. That's a fact.

Senator MOYNIHAN. The next thing you'll say is B-2s.

Senator SYMMS. The war on drugs. It is spent on various favorite projects and programs of different Members of the Congress. But I don't think that the Congress can get away with this without taking their share of the responsibility for it. I just think that we ought to spend $19 billion a year. We should start right now and take it out of some other expenditures of the Federal Treasury.

Senator MOYNIHAN. We'll talk to Tom Larson about it.

Senator SYMMS. I think that's the question.

Mr. Chairman, I want to apologize, but I have an appointment that I have to keep this morning and I'm going to have to leave also.

Senator MOYNIHAN. Well, I'll see that Tom Larson——

Senator SYMMS. Addresses how much we can spend without a tax increase.

Senator MOYNIHAN. Senator, thank you very much.

Senator WILSON. Mr. Chairman, thank you. Let me make one final point.

Senator MOYNIHAN. Please do.

Senator WILSON. I think that it would be relevant to the considerations of the committee. You are concerned with infrastructure here, but I know that you are also concerned with the immediacy of the response to people who are in trouble in need of disaster relief.

A month or two before this disaster occurred, in August of this year, there was a major exercise simulating a major quake. It is clear that not only can you prepare for a disaster by the kind of seismic requirements in a building code that Senator Reid has properly dwelled on this morning, but also the necessity for different agencies to plan, to foresee, and to actually go through the drill of providing those services is absolutely essential.

What occurred in this instance was remarkable coordination between Federal, State, and local agencies. I think they have been widely praised, and quite deservedly so.

Thank you, Mr. Chairman.

Senator MOYNIHAN. Thank you.

Senator WILSON. I wonder if I might ask a further courtesy of being permitted to sit with the subcommittee.

Senator MOYNIHAN. Please do. We would be most happy. Senator Symms has to leave, so why don't you just take his place.

Senator WILSON. Thank you.

Senator MOYNIHAN. And I have a statement by Senator Cranston I'd like to place in the record at this point.

[Senator Cranston's statement follows:]

STATEMENT OF HON. ALAN CRANSTON, U.S. SENATOR FROM THE STATE OF CALIFORNIA

Mr. Chairman and members of the committee, I am deeply, deeply appreciative of your swift work in convening this morning's hearing to address the devastating disaster experienced in Northern California on Tuesday, October 17, 1989, at 5:04 p.m.

The damage estimates from the Loma Prieta earthquake continue to mount as aftershocks continue and more structural damage is uncovered. In the past few days, I have done a county-by-county survey of estimates of private and public damage which currently exceeds $7 billion. Those figures are certain to increase over the next few days.

My county-by-county survey as of 5 p.m. EST on Saturday, October 22, is as follows:

Alameda: $1.51 billion ($490 million public, $1.02 billion private).
Monterey: $100 million ($40 million public, $60 million private).
San Benito: $100 million ($20 million public, $80 million private).
San Francisco: $2.5 billion ($500 million public, $2 billion private).
San Mateo: $350 million ($50 million public, $300 million private).
Santa Clara: $560 million ($150 million public, $410 million private).
Santa Cruz: $1 billion ($200 million public, $800 million private).

In addition, the California Department of Transportation estimates the damage to Federal highways at $1 billion.

Clearly, this disaster is one of the most costly, if not the most costly, natural disasters in our history.

The combined resources of the Federal Government, State and local governments, and the private sector must be tapped to help rebuild and repair the damage and destruction.

The human suffering and anguish can never be compensated, but we can attempt to deal to the extent possible with the physical and economic losses.

Again, I deeply appreciate the support which the chairman of the subcommittee, Senator Moynihan, has so swiftly expressed. I look forward to working closely with the subcommittee and full committee in the days and weeks ahead as we move forward with responses to this California and national disaster.

Senator Moynihan. We're going to also ask Brigadier General Kelly, who is the Director of Civil Works of the Corps of Engineers—General Kelly, if you don't mind—and I'm sure you will not—we are going to have Doctor Larson join you. I'd like to hear from our two professionals, General Kelly and Doctor Larson.

Doctor Larson, come forward please and sit down, sir.

General Kelly, we welcome you and we look forward to your testimony.

STATEMENT OF BRIG. GEN. PATRICK KELLY, DIRECTOR, CIVIL WORKS, U.S. ARMY CORPS OF ENGINEERS

General Kelly. Thank you, Mr. Chairman.

It is a pleasure to be here this morning. I will just cover briefly our activities involved in natural disasters and how we support the other Federal agencies. I might point out that because of our civil works mission with the Corps of Engineers, we typically get involved in many disasters every year—probably somewhere in the vicinity——

Senator Moynihan. Excuse me, sir. Will the staff attend to the General's testimony the way the Senators are? And will the audience, too?

Thank you, sir.

General Kelly. Thank you, Mr. Chairman.

As I was saying, we probably get involved in 10 to 20 natural disasters a year. I might point out that right now we are involved in five. We are involved in a very severe drought, as you probably know, Mr. Chairman, in North and South Dakota, and parts of Iowa. We are also involved in a drought situation on the Mississippi River that affects navigation between St. Louis and Cairo. We are involved in——

Senator Moynihan. It's not a flood on the Mississippi. It is a drought.

General Kelly. Yes, sir. Right.

Senator Moynihan. You were first down the Mississippi in about 1778 or 1779.

General Kelly. Yes, sir. It was the latter part of the 18th century.

Senator Moynihan. Yes. More than two centuries ago that you were down, and you still haven't fixed up the Mississippi?

General Kelly. No, sir. Not yet.

Senator Moynihan. Well, patience. We get medals for patience.

General Kelly. We are involved in two hurricanes. I'll go into a little bit about what we are doing in support of FEMA in Hurricane Hugo, but there also was Hurricane Jerry which hit Galveston and Houston. We have people down there right now assisting in that.

As you will see in a minute, we are deeply involved in the San Francisco earthquake.

And we've got a flood right now in Eastern Kentucky.

Those are very, very typical of a lot of the operations that we do.

Because we are in the Department of the Army and the Department of Defense, we really have both agencies to support in any sort of a natural disaster. They call upon our expertise—either engineering, technical, or otherwise. And, because of our civil works mission, FEMA looks to us to provide a lot of engineering expertise, as well as operational expertise, in any sort of a disaster.

In the case of Hugo, we had a resident office in the Virgin Islands, as well as an area office in Puerto Rico. Both offices are part of our Jacksonville District, South Atlantic Division. So we were on the site almost momentarily as soon as that hurricane came across and devastated the Virgin Islands and Puerto Rico.

The first thing we were asked to do by FEMA was to make a critical assessment of the power needs. There was absolutely no power. We did that. We also worked with the U.S. Geological Survey in taking some existing wells that they had just drilled, purchased some pumps, and provided emergency power for both water supply and water distribution. Senator, I might point out that that mission is still continuing to this day.

The other thing that we were asked by FEMA to do—and do very quickly—was to provide emergency housing. A majority of houses in the Virgin Islands had been damaged or destroyed. We immediately put in contracts, using local contractors, for installing plastic roofing material. That mission will involve about 3,000 homes. We have completed 1,000 already, and probably within the next couple of weeks will have most of the remaining 2,000 accomplished.

Senator MOYNIHAN. General, if I could just interrupt to say—and I want the record to reflect—that I was with you on St. Croix eight days ago, Sunday of last week. The Corps of Engineers has been superb.

I can say to my colleague, Senator Wilson, that the scale is a very different one, but the proportions are extraordinary. A third of the houses on St. Croix don't exist. They are not there any more. There was no water. There was no power. There was no food. And the Army Corps of Engineers got in there. There is almost no natural water on St. Croix at all. It is a dry island. In the midst of a hurricane disaster the Corps looked up the fellows from the Geological Survey, and in 48 hours they had drilled the first wells in history on St. Croix and suddenly there was water to drink. The field hospitals—the whole operation has just been superb.

I'd like it on the record that St. Croix is American territory and those are American citizens. Lest we run out of time, I wanted to say what a job the Corps did down there.

General KELLY. Thank you, Mr. Chairman. We really appreciate that.

We have nearly 100 people on the Virgin Islands right now doing work in support of FEMA, and we'll probably remain there for the rest of the year because there will be just a tremendous amount of reconstruction activities that are going to take place.

I won't go into some of our activities in Puerto Rico because they were very similar to what we did in the Virgin Islands, but in Charleston, of course, we also got deeply involved in assisting FEMA. We did most of the initial damage assessments for FEMA and provided that information to them so that they could get an estimate of the costs involved in the recovery.

The first thing we had to do was to provide a temporary access to Sullivan's Island. We took the existing bridge that was damaged and temporarily repaired it. It was off its pedestal. We put it back on its permanent pedestal so that we could get vehicular transportation to the Isle of Palms and Sullivan's Island. In the meantime, the Army brought in an emergency float bridge arrangement to provide temporary transportation until the Corps of Engineers could temporarily repair the bridge, and that arrangement was operational within 24 hours.

The State was very concerned in both South and North Carolina about a very large tide that was coming in on the 15th and 16th of October, last week. We were asked by FEMA and the States to provide dunes to protect the existing facilities and homes against a further devastation caused by that tide. We did that. I might point out there was very, very little damage. We got the dunes in just in the nick of time.

We are now assisting FEMA in the debris removal mission and have substantial contracts in place or will be placed in the next couple of weeks.

In San Francisco, again it was fortuitous that we had an organization in place, as we do in many places. We had one of our districts, the San Francisco District——

Senator MOYNIHAN. You were a commander of that district, were you not, sir?

General KELLY. I was previously the commander of the division, sir, which also is located there.

Senator MOYNIHAN. The division?

General KELLY. Yes, sir. We had our district in place. We had a division in place. And, in addition to 6th Army located at the Presidio, the FEMA regional headquarters is also located at the Presidio, so we had a good organization in place to react to the disaster.

Right after the earthquake occurred, the first thing we did, because we have a number of large flood control dams, was that within one hour of the earthquake we went out and inspected all of our flood control dams and had that report in by midnight of that day—which I believe was Tuesday. There were no damages to any of our flood control structures.

Senator MOYNIHAN. So the first thing you thought to do and had drilled to do was to check those dams up in the mountains?

General KELLY. Yes, sir. That's part of our plan.

Senator MOYNIHAN. And it is very quiet work. No one notices.

General KELLY. No, sir.

Senator MOYNIHAN. Nothing happened.

General KELLY. And I'd like to emphasize what Senator Wilson said—and I must compliment FEMA on this because they have provided the leadership on this all along. They have worked very hard over the last ten years to put together a very viable earthquake response plan. That plan has been continuously updated. It was updated again after the Whittier earthquakes in 1987. As Senator Wilson said, FEMA sponsored and got all the Federal and State agencies involved in a response exercise just this August. I'm sure Larry Zensinger from FEMA will cover that. But the basic plan and the basic response that was played out in that exercise in August actually took place almost item for item, mirror by mirror, this past couple of weeks.

Senator MOYNIHAN. So those government bureaucrats did that, did they?

General KELLY. Yes, sir.

Senator MOYNIHAN. And public servants, mind you, but that's another matter.

General KELLY. We have been deeply involved in doing preliminary and detailed damage surveys for FEMA. The latest mission we have got—and it dovetails very nicely to how we carry out our actions—was very late—in fact, as you remember, Senator, you and I had a conversation late Friday evening. I got back to the office, and we received another mission from FEMA. Because FEMA is deeply involved in Hugo, they do not have all the necessary people to carry out a lot of the mission in the individual assistance arena—in particular, damage inspection. They called upon us and said, "We need 300 people by Monday morning ready to go to work." And so we sent a message out that night to our divisions and districts.

Immediately we had volunteers, and we had 100 people on site on Saturday, 225 by Sunday morning, and now all 300—in fact, we've got an extra 25 people. There are 325 people that have assembled in Sacramento ready to go to assist FEMA in their disaster assistance centers. And that's going to be crucial, because as the individual owner comes in and requests assistance he is going to need some sort of engineering verification, and that's where our people will take action. So we are very, very proud of what our people are doing.

Senator MOYNIHAN. Senator Wilson would like to ask you about that.

Senator WILSON. General, these 325 personnel, who are they? Where are they from?

General KELLY. Sir, they are from all over the United States.

Senator WILSON. Are they Corps personnel?

General KELLY. They are all Corps personnel. Yes, sir.

Senator WILSON. That's extraordinary.

General KELLY. All Government employees.

Senator WILSON. Now I understand where the 500 came from—at least 325 of them.

General KELLY. I'll let Larry cover the details, but we had 325 people on site to assist FEMA.

The other thing we are involved in right now is that, of course, we are doing various inspection of bridges, levees, and we've got some emergency work going on right now. That checks with what you had said earlier. Because of the Bay Bridge going out, they've got to institute ferry service both from Berkeley and probably from Oakland, and we've now got emergency dredging that is taking place to open up the channel so we can get the ferries in and out.

And we are involved in some other things, Senator, but I will cover that perhaps in questions and answers.

Senator MOYNIHAN. General, stay right where you are and we'll hear from Doctor Larson. But may I note that government is a complicated business, and most of it goes on when people aren't noticing. But when it comes time to do emergency dredging, someone has thought about how you might do it ahead of time and it gets done. That's very impressive.

I would like to hear from Doctor Larson. We welcome you, sir, for your first substantive appearance before our committee. Tell us what you think is going on out there. Respond, if you would, to Senator Symms questions. We'll hold general questioning until you are through, although perhaps I could throw a question at the beginning, too. How long is it before that Bay Bridge is going to be working? I would have thought some time. You get to that when you are ready.

I see you have a statement. That will be placed in the record. You may proceed as you wish.

STATEMENT OF THOMAS D. LARSON, ADMINISTRATOR, FEDERAL HIGHWAY ADMINISTRATION, ACCOMPANIED BY EUGENE R. McCORMICK, DEPUTY ADMINISTRATOR AND STANLEY GORDON, CHIEF, BRIDGE DIVISION

Mr. LARSON. Thank you, Mr. Chairman.

I am here to testify in general this morning on the Northern California earthquake of October 17, 1989, and its effect on highway transportation, in general, and about S. 1775, introduced by Senator Symms on October 20, 1989, in particular.

As you are aware, President Bush, Vice President Quayle, and Secretary Skinner visited the San Francisco area in the aftermath of the earthquake. One purpose of these visits was to begin an immediate assessment of the funding requirements to promptly repair the areas transportation systems. The main focus of attention today is the availability of emergency relief highway funds in fiscal year 1990 and the potential elimination of legislative restrictions on their use.

It will be several weeks before accurate assessments are available on the cost to repair I-880, other freeways and Federal-aid highways, and the Bay Bridge. There are something like over a dozen projects that are, in fact, under this assessment.

Expanded interim ferry service will also be required.

The major source of highway funding for emergency repairs is the federal aid highway emergency relief program. At this time, some $220 million is available in fiscal year 1990, including prior year carryover funds and adjusting for sequestration. This is a nationwide source of funds; however, as the committee is aware, there are several statutory restrictions at the present time on the use of emergency funds. These include: obligations cannot exceed $100 million per State per disaster; obligations cannot be made for most toll facilities—for example, the Bay Bridge; and the Federal share may be 100 percent for emergency restoration of traffic during the first 90 days, then normal State and local cost sharing is required.

California will also receive approximately $900 million in formula allocated highway funds in fiscal year 1990 in categories that would be eligible for use in restoring bridges and highways on the Federal-aid system in the San Francisco Bay area. However, this funding is available in a series of specific categories which have limited correlation to the damage. It is likely that California would make available to the Bay Area almost $300 million of its Federal-aid allocation, and approximately $150 million in State and local funds.

Of course—and let me stress this—shifting funds beyond what was already planned for the San Francisco area would also disrupt ongoing programs elsewhere in the State.

One additional complicating factor in determining available emergency funds is the need to cover outstanding claims from Hurricane Hugo's damage. Although no formal request has been received, FHWA expects highway claims in the order of $50 to $70 million from South Carolina, the Virgin Islands, and Puerto Rico.

The Department of Transportation is responding fully and promptly to the tragic events in California. Specifically, the department is undertaking the following course of action: Secretary Skinner has already announced that FHWA will make $100 million in emergency relief highway funds immediately available—let me stress this can be made immediately available to California as the State applies and submits claims in an expedited process. The California Department of Transportation transmitted a letter of intent to request funding, and FHWA has assured California of immediate action. These are the first steps in flowing this money. These have been taken.

Senator MOYNIHAN. Can I ask, Doctor Larson, if you have heard from South Carolina, Puerto Rico, and the Virgin Islands?

Mr. LARSON. As I have noted, we have not had a formal request. We expect that the amount would be in the $50 million to $70 million range.

Senator MOYNIHAN. And you have that money on hand as well in the account?

Mr. LARSON. Yes, indeed, sir.

Senator REID. From where?

Mr. LARSON. South Carolina, the Virgin Islands, and Puerto Rico. Those were lumped together.

The Administration will work with Congress and California in support of an appropriate increase in fiscal year 1990 for emergency relief, either as direct appropriation or contract authority specifically to aid California. Given the importance of restoring the Bay Bridge to facilitate traffic in the area, we will also carefully review the repair costs of the bridge and the State's provision for insurance on the bridge to determine the residual costs that could be funded from emergency relief if Congress waived the toll road prohibition affecting such funds.

Of course, we are ready at all times to work with the committee and the entire Congress to produce legislation to aid California. Senator Symms' bill addresses some of these issues. It provides for emergency relief funds from the Highway Trust Fund specifically for the damages suffered from the earthquake by providing such sums as may be necessary. Such sums would have contract authority and be immediately available for obligation. They would not be subject to any obligation limitation consistent with current law. They are exempted from the $100 million cap per State per disaster. They could be expended for damages on the Bay Bridge after the application of insurance payments.

While we strongly support the general goals of S. 1775 to provide needed relief to California which are consistent with the Administration's actions, we do oppose open-ended commitments of highway trust funds. Moreover, an accurate and complete assessment of the needs of California has not been made.

Six technical teams, of Federal Highway Administration, and State officials will begin the detailed assessment of needs tomorrow. We expect this effort to be completed in six to eight weeks.

Mr. Chairman, at this point I would like to turn to the subject of earthquake protection standards—something we have heard something about this morning.

Senator MOYNIHAN. Indeed.

Mr. LARSON. Bridge retrofit. Design requirements for retrofit of existing bridges are the same as for new bridges; that is, when an existing bridge is evaluated for possible retrofit, the same dynamic analysis and earthquake resistance capability must be provided. States and other bridge owners in earthquake-prone areas have considered the need to retrofit existing bridges as one of the many priorities for bridge safety improvements. States such as California—and I might add Nevada—have undertaken a comprehensive program within available funding limitations. Other States which have not experienced a damaging earthquake in this century have placed a lower priority on retrofit.

Generally, the existing bridge design specifications are adequate for the design of new bridges and retrofitting existing bridges. However, as additional experience is gained and research is completed, appropriate adjustments in the design requirements will be made. As you have pointed out, Mr. Chairman, we are learning and applying that experience as we go forward.

As researchers improve their knowledge of the probability of actual forces and the displacements likely to be caused by earthquakes, the design codes will, of course, continually be adjusted.

This concludes my statement, but I will address the two questions that were posed to me, Mr. Chairman, if I may.

The first question from Mr. Symms was on the spending levels supportable by the trust fund. He used the figure of $19 billion per year. The estimates that have been prepared would support that level for perhaps four years of spending if conditions remained the same. This is a slow process—funds coming in, funds going out—and that level of expenditure would be supportable in the near term.

On the question of the Bay Bridge, the Bay Bridge question is addressed in Senator Symms' legislation, and the funding for that is something that we will give very careful consideration to.

Senator MOYNIHAN. My question, Doctor Larson, was: how long do you think we should estimate it will be before the Bay Bridge will be opened?

Mr. LARSON. I think the estimate that I heard earlier of a month to six weeks is probably the best estimate we have.

Senator MOYNIHAN. And we have your testimony sir that with respect to S. 1775 or whatever legislation—this committee will report legislation, obviously—you oppose open-end commitment of highway trust funds?

Mr. LARSON. That is correct, sir.

Senator MOYNIHAN. Thank you.

Senator Reid?

Senator REID. What do you mean by opposing open-ended commitments of highway trust funds?

Mr. LARSON. Simply that we think it would be prudent to have an estimate of the appropriate cost to be borne by the Federal Highway Administration fund, and that we will work aggressively to meet those needs.

Senator REID. It would seem, Mr. Chairman, if we have $19 billion available for the next four years, then it is true what Senator Symms said, basically, that the money that we are not spending is just being borrowed against.

Senator MOYNIHAN. Sure.

Senator REID. And that certainly would go a long ways toward our truth in budgeting if we spent the money that the people had paid into the trust fund for infrastructure development.

Senator MOYNIHAN. They paid it for these purposes. Yes, sir.

Senator REID. I think the questions that I have I'd like to submit to Doctor Larson in writing. They probably aren't a lot of value to the committee, as a whole. They are more related to the Department of Transportation's role in the nuclear waste project which I have harped on a lot on this committee, so I will submit those to you in writing.

Mr. LARSON. Thank you, Senator.

[The questions and answers thereto follow:]

Senator Reid

QUESTION NO. 1

Mr. Larson (FHWA), what is the Department of Transportation doing to improve the ability of our nation's bridges to withstand the forces of a major earthquake?

ANSWER

The Federal Highway Administration (FHWA) has carried out extensive seismic design research, development and training activities for more than two decades.

After the 1971 San Fernando earthquake, the FHWA funded numerous research projects to improve the seismic design of bridges. These culminated in a contract to the Applied Technology Council of California to compile a new set of Design Guidelines based on the results of this research. Published in 1981, the ATC-6 Seismic Design Guidelines for Highway Bridges were adopted by The American Association of State Highway and Transportation Officials (AASHTO) in 1983 as "Guide Specifications for Seismic Design of Highway Bridges." These specifications represent the state-of-the-art in seismic design for bridges and are recommended for the design of all new bridges throughout the United States. The guidelines are appropriate for both new designs and retrofit of existing bridges.

In 1982, the FHWA also developed a Seismic Design of Highway Bridges training course which was made available to the States. It was updated, combined with research findings and incorporated into a 1987 Seismic Design and Retrofit

Manual for Highway Bridges. This was immediately made available to all States. California, Nevada, Washington, Illinois and Utah have since retrofitted bridges to increase earthquake resistance. At the same time, the FHWA updated its seismic design week-long training course, held two pilot sessions, one in California and one in Portland, Oregon, and announced its availability through FHWA's National Highway Institute. Most States in moderate to high seismic risk areas have indicated an interest in the course. This training will be conducted in FY 1990 as many times as needed to meet the demand.

On October 23, 1989, an electronic message was sent to all FHWA field regional offices requesting that all double decked viaduct structures be identified, inspected and evaluated for seismic risk and retrofit.

On November 6, 1989, a memorandum from Acting Executive Director, E. Dean Carlson was sent to FHWA field offices reminding them of the seismic design requirements for bridge projects constructed or rehabilitated with Federal-aid funds and recommending that existing bridges in moderate to high seismic risk areas be promptly evaluated and retrofitted, where needed.

The FHWA is participating in a California blue ribbon panel established to evaluate bridge performance and the State Seismic Design and Retrofit Program. The findings of this panel combined with technical knowledge gained from other investigators of seismic bridge performance in the Bay Area plus results of ongoing seismic research and general evaluations of existing seismic design requirements for bridges will no doubt lead to improvements in the AASHTO seismic design requirements. The FHWA intends to continue to work with AASHTO and the individual States to promptly implement any new findings into everyday practice.

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Senator Reid

QUESTION NO. 2

What specifically will DOT do to improve the safety of those routes leading to Yucca Mountain should it be chosen as the nation's nuclear waste repository?

ANSWER

We make Federal-aid highway funds available to States through formulas established in Federal law. These funds can be used to construct, upgrade and make safety improvements to routes that are on Federal-aid highway systems within the State, including those significant to waste disposal. It is, however, the State's responsibility to determine which projects will receive these funds and to set project priorities. The DOT will give full consideration to any proposal advanced by the State for improving the safety of any route on the Federal-aid system.

Senator Reid

QUESTION NO. 3

What assurances can you give me that a shipment of nuclear waste, traveling by road or rail, will survive a quake of at least the magnitude that hit California last week without releasing radioactive waste?

ANSWER

The Nuclear Regulatory Commission (NRC) establishes the standards for nuclear waste shipping containers. These standards emulate both normal and accident conditions and require the container to--

- prevent the loss or dispersion of radioactive contents,
- provide adequate shielding and heat dissipation, and
- prevent criticality.

These standards require each container to survive severe accident conditions, such as fire, impact, and puncture. Sandia National Laboratory, Albuquerque, New Mexico, confirmed the NRC criteria, for casks used in rail shipments, in a series of tests. One test subjected the shipping cask to a 30-foot drop onto an unyielding surface, which produces about the same impact as a 90-mile-per-hour crash into 2 feet of reinforced concrete. A second test determined how well the cask would absorb the impact of protruding objects by dropping the cask 40-inches onto the end of a steel rod. A third test subjected the cask to a 1472 degree Fahrenheit fire environment for 30-minutes. During each of these tests, the cask was monitored for detectable leakage by x-ray, which indicated no detectable displacement of the lead shielding nor leakage from the primary or secondary containment vessels.

Although we cannot assure that no release of nuclear material will ever occur, the DOT, in cooperation with the NRC, has conducted several tests under extremely severe accident conditions to gather information for cask design to reduce the risk and probability of release.

Senator Reid

QUESTION NO. 4

In light of last week's quake, will DOT recommend to DOE not to place the nation's nuclear waste repository on top of an earthquake fault?

ANSWER

The Department defers to the Secretary of Energy on the final selection of a site.

Senator **Moynihan**. We might well harp on it. They want to put it in your State. That seems to me not unreasonable.

Senator Wilson, do you have any questions you might like to address to Mr. Larson?

Senator **Wilson**. Thank you very much, Mr. Chairman. Let me pick up on your line of questioning to Doctor Larson.

Doctor, tell me what really is the significance of the statement that the Administration opposes open ended? How does that apply to the phrase that it has chosen quite deliberately in S. 1775, "Such sums as may be necessary."? We're talking about damage which may be extensive, but it is, after all, finite. The phrase "such sums as may be necessary" will describe that finite amount when, in fact, it is determined. No one at this point is in a position to say what it is.

You have said that your own teams will take six to eight weeks. But at the end of that six to eight weeks they will know, and I think probably come to a judgment that is somewhat the same as that of the professionals who are working in the State.

I can understand why you would be against open-ended funds, but we're not proposing open ended. What we are proposing is what is necessary to make the repair.

Mr. **Larson**. There are two points, Senator.

First of all, in terms of timing it is important to note that I said that $100 million is immediately available, so there will be no delay on the early actions that are, in fact, required.

In terms of the language, the intent is simply to have the bounds of reasonable estimates. The intent is not to raise questions about the availability of funds at this early time.

Senator **Wilson**. Well, I understand and appreciate the fact that the $100 million will be made available in a timely fashion, but what we are getting at is a long, long haul on that section of the Nimitz Freeway. I have in my hand—it was just given to me—an executive summary provided by the Office of Emergency Services in Sacramento—the office of the State of California.

Their current estimate is that—well, I will simply read it to you: "Numerous teams are in the field, including State teams, inspecting hospitals and State buildings, food supplies, pharmacies, and highways. State engineers continue doing preliminary damage assessment of locally owned government facilities. Cal Trans is working to permanently repair damage to the Bay Bridge. The current estimate to reopen the Bay Bridge is four weeks. The Cypress section of the Nimitz Freeway, I-880, is June, 1992." That's June, 1992, which strikes me as about what I would have guessed.

Obviously, it is going to require more than $100 million. Cal Trans estimates that December will permit reopening State Route 17 in Santa Cruz County; and in February, 1990, and June, 1990, the damaged portions of Interstate 280 and Interstate 480, respectively, in San Francisco.

So we're talking about not only a cap that is clearly inadequate for the damage that is attributable to this quake in the Bay Area and all the particulars that this summary recites, but one that is clearly going to exceed both the time permitted and the financial cap that is presently involved.

The phrase, "Such sums as may be required,"——

Mr. LARSON. We recognize that the $100 million is probably less than will be required. It is not a cap that we view as the limit of our expectation there. The question is one of language. We, in the Administration, will clearly work with the Congress as time moves forward. It is our intent that there not be a delay in the early actions, and that's why the $100 million is pointed to.

Senator REID. Senator Wilson, would you again repeat the dollar figures of those estimates that you have from the State of California? Or were there any there?

Senator WILSON. No. We don't have any dollar estimates.

Senator REID. Have we had any——

Senator WILSON. What these are are estimates as to the date that these facilities that have been damaged can be reopened.

Senator REID. I wonder if we have any estimates as to the two major transportation facilities—the bridge and that freeway. Does anyone have any idea what the cost estimates are on those two items, alone?

Mr. LARSON. The freeway has been very roughly bounded by such figures as $100 million to $200 million, but I would not want to verify those numbers. I don't think anybody has a number at hand at the present time.

Senator MOYNIHAN. We happen to have a witness who is supposed to be in San Francisco, Professor Buckle from the Earthquake Center at the State University of New York in Buffalo, and I don't want to keep him from getting out there.

But I want to be clear about one thing, Doctor Larson. You do accept that legislation will be necessary from this committee?

Mr. LARSON. Yes, sir.

Senator MOYNIHAN. And the Administration has no legislation?

Mr. LARSON. We will work with the Congress to develop legislation.

Senator MOYNIHAN. You haven't come here with a bill and no one has told you that you are able to say that a bill will be sent up?

Mr. LARSON. I have not come here with a bill. No, sir.

Senator MOYNIHAN. Yes, sir. Well, we'll send one down. We thank you very much.

General Kelly, will you give this committee's appreciation—I'm sure Senator Wilson will join in—to those volunteers who showed up over the weekend for FEMA?

General KELLY. Yes, sir.

Senator MOYNIHAN. That sounds like the Corps of Engineers. They're all soldiers, and we appreciate them.

General KELLY. Thank you.

Senator WILSON. Mr. Chairman, while the General is leaving the table let me echo your applause for the volunteers. This summary also recites that teams consisting of personnel from the Department of Water Resources and the Corps of Engineers continue to inspect the dam within a 54-mile radius of the earthquake epicenter. The reason that they are doing so is perfectly obvious. But the impact on infrastructure, as indicated in this next statement, the Department of State Parks reports beach closures from Monterey County south to Point Lobos, and in Santa Cruz County from Lighthouse Point to Brighton, due to contaminated water from raw sewage—raw sewage occasioned by breaks in the sewer mains that is now flowing into the ocean and back onto the beaches.

Senator MOYNIHAN. There you are. One of the miracles down in St. Croix is that there have been no viral infections at all—no typhoid.

Thank you gentlemen very much.

Now we are going to conclude our morning with a panel of experts in emergency management, two of whom I am happy to say come from two great engineering schools of the State of New York.

Will Mr. Zensinger, who is the Chief of Public Assistance Programs for FEMA come forward?

Is Professor Buckle on hand? There you are, sir. Come forward. We welcome you.

And Doctor Ahmad, there you are, sir, right in the middle.

Why don't you all three get together as if you knew each other?

We are happy to have such distinguished engineers. I think probably you both are engineers. Doctor Buckle is the Deputy Director of the National Center for Earthquake Engineering Research of the State University of New York at Buffalo. We are very proud of that, having won that competition. I know that Senator Wilson will be interested—he probably knows—that Governor Deukmejian has asked Doctor Buckle to come out to California to look and see what has happened and see what ought to be done and address future standards. We'll hear from you. You tell us. We're not going to tell you what you're going to do.

Doctor Ahmad is Chairman of the Department of Civil Engineering at Cooper Union College, one of the great institutions of the City of New York.

We will proceed as the witness list says. I'm going to ask Mr. Zensinger to keep his testimony to five minutes, if you would. I think we need to note at this point that we would have asked the director of the Federal Emergency Management Agency to come speak to us, but there is no director. That is something overlooked. A year has gone by, and we haven't even had a nominee. It is not that we haven't processed, it is just that—I think it should be recorded that earthquakes don't wait. But, in any event, there is no director. We asked the deputy director, and he couldn't come—Mr. Peterson, for whom this Senator has some great regard, having been with him on St. Croix eight days ago. But I don't know why the Administration couldn't have sent him. In any event, Mr. Zensinger, you are welcome, sir. We will take your testimony.

STATEMENT OF LAWRENCE ZENSINGER, CHIEF OF PUBLIC ASSISTANCE PROGRAMS, FEDERAL EMERGENCY MANAGEMENT AGENCY

Mr. ZENSINGER. Thank you, Mr. Chairman.

First, I'd like to say Grant Peterson was fully prepared to be here today and was planning to do so up until 9:00, at which time he received a call and was directed to go to the White House for consultation. He asked me to extend to you his personal apologies for not being here.

Senator MOYNIHAN. So the White House thought it was more important for him to be there than to appear before this committee?

Mr. ZENSINGER. Yes; that's what happened.

Senator MOYNIHAN. Nothing the matter with you. You give a straight answer. Thank you.

Mr. ZENSINGER. I would like to give you a brief update as to where we stand with respect to the earthquake, and I'd be happy to answer any questions concerning Hurricane Hugo. I'd like to also address a couple of Senator Wilson's questions.

As of yesterday at 1:00 we opened seven disaster application centers, one in each of the declared counties in California. As of 8:00 p.m. yesterday we had taken 6,244 applications for assistance from Californians. This includes people who applied at the centers, as well as people who have applied over our hotline over the last few days. As you know, we have a hotline which is staffed 24 hours a day which has the ability to take applications in 13 languages.

We have 100 lines on that hotline. We are going to 200 in the next couple of days. We have over 400 people staffing that operation on a 24-hour basis. Those are mostly FEMA employees, reservists, as well as local hires.

Senator MOYNIHAN. Could I just say that I was very impressed when I first heard that. Thirteen languages shows you were thinking ahead of time.

Mr. ZENSINGER. In addition, we did hold training yesterday at the Presidio for 500 individuals. Let me clarify some of the numbers that were thrown around as far as individuals are concerned. Those 500 that we trained yesterday included volunteers from other Federal agencies in the San Francisco area. They were FEMA employees, they were reservists, and a significant number of State employees that were made available by the State of California—Social Services sort of people. So we have HHS and California Social Services and a variety of other Federal agencies all volunteering to participate in this effort. That was the 500 figures that was trained yesterday. The 300 people that are coming in from the Corps are in addition to that 500 and are going to be used for inspections. The first 500 are going to be application takers, essentially—registrars. We will then have to do the inspections.

We are looking into doing everything we can to expedite the application process, including some of the suggestions that have been made for utilization of local inspectors and for perhaps expediting the verification process.

At the present time we have damage assessment teams who are working with the State personnel and the local individuals out trying to get a handle on the magnitude of the damage. As you recognized, earthquake damage is something that it takes a great deal of expertise to define. You can look at a building and it has some cracks and you don't know whether the cracks just require some patching or whether the building needs to be replaced. You generally don't know that until you do a detailed engineering analysis. So for us to get a very detailed identification of the extent of the damages is going to take some time.

I would like to mention that with respect to FEMA's assistance programs, we have, under the public assistance program, the ability to provide assistance to the State and local governments for the repair, restoration, or reconstruction of any public facilities that were damaged, special purpose districts, port authorities, and any other kind of public entities and eligible applicants.

Things that are eligible for assistance include flood control, navigation, irrigation, reclamation, public power, sewage treatment and collection, water supply and distribution, watershed development, and airport facilities.

In addition, we can provide assistance for the repair of all non-Federal aid streets, roads, and highways, including bridges and that sort of thing.

In addition, our law provides emergency public transportation authority. Under this authority, we have the ability to provide emergency public transportation in an area affected by a major disaster to meet immediate needs and to provide transportation to governmental offices, supply centers, stores, post offices, schools, major employment centers, and such other places as may be necessary.

Under this authority, FEMA, in the past, has typically provided funding for such things as alternate access routes, temporary bridges, emergency mass transit—including buses, trains, ferries, and other temporary emergency transportation methods.

Senator WILSON. Mr. Zensinger.

Mr. ZENSINGER. Yes, sir?

Senator WILSON. What are the limits on that assistance?

Mr. ZENSINGER. This is only limited by the need. It is funded at 75/25. It is reimbursable to local governments. All of the costs for emergency transportation that are being incurred by local authorities are reimbursable expenses for as long as they are needed until permanent restorations take place.

Senator MOYNIHAN. The chairman will note that in the last Congress we went over this statute and enacted the Robert T. Stafford Act, which is the present statute, and it is a very comprehensive one. The committee knows of the act, Mr. Zensinger, so why don't you tell us what you think we need to know about events in the last six weeks and we'll get on to your fellow witnesses.

Mr. ZENSINGER. I'd just like to conclude, I guess, by saying that we do have operations currently ongoing on St. Croix and on St. Thomas. I had the pleasure of accompanying your trip to St. Croix last weekend with Mr. Peterson. We have an operation going in Puerto Rico where we expect as many as 200,000 individual applications.

Senator MOYNIHAN. That's 200,000 in Puerto Rico?

Mr. ZENSINGER. Family applications. We're expecting in the vicinity of 50,000 applications in South Carolina and a smaller number in North Carolina. In addition to the earthquake, we also have preliminary damage assessment teams, and I don't think General Kelly knows this yet, but he was sending some of his people out to help us with PDAs there—damage assessments—in Kentucky. So we are busy.

Senator MOYNIHAN. Pretty rough schedule. In the continent, if it is not Alaska it is St. Croix or some point in between.

We thank you, sir, and we'll get back to questions.

Doctor Buckle, it is an unexpected pleasure to have you here, though not the happiest circumstances, of course. But we welcome you and we look to you as we will to Doctor Ahmad for your advice.

STATEMENT OF IAN BUCKLE, DEPUTY DIRECTOR, NATIONAL CENTER FOR EARTHQUAKE ENGINEERING RESEARCH, STATE UNIVERSITY OF NEW YORK AT BUFFALO

Mr. BUCKLE. Thank you very much, Mr. Chairman. It is a pleasure to be here and to appear before you and your committee.

As you have correctly stated, I am the Deputy Director of the National Center for Earthquake Engineering Research, which is located on the campus of the State University of New York at Buffalo. But probably of equal interest to the members of your committee is the fact that I am a civil engineer with special expertise in bridge and earthquake engineering.

Prior to moving to Buffalo, I lived for five years in the East Bay. I worked for a consulting company that specialized in earthquake engineering. One of the projects that I undertook whilst working with that company was to write this manual for the Federal Highway Administration called the Seismic Design and Retrofit Manual for Highway Bridges.

Senator MOYNIHAN. Retrofit meaning getting older structures up to date?

Mr. BUCKLE. Updating old bridges to meet modern codes. I have copies for you. And Mr. Gordon, who was here in the audience and I believe has just left, also left copies of the same manual with you.

I saw him leave some up front, and I'll leave this one.

Senator MOYNIHAN. Thank you. I don't think we'll put it in the record. We're going to need that money for the Bay Bridge. But we will have it in our library, I assure you.

Mr. BUCKLE. One reason for referring to it, Mr. Chairman, is the fact that it is an overview of the state of the art of seismic design of highway bridges. There are chapters in there which describe typical damage to bridge structures in earthquakes. It also describes what is considered to be good and bad (or poor) structural form. It also has sections on retrofit—current methods of retrofit and proposed methods of retrofit. I believe it is a useful document for anybody who is concerned with understanding what has happened to the Cypress Street viaduct. It will be a very useful reference work and a good base for addressing the problem intelligently, sir.

I went to the Bay Area on Wednesday evening (Oct. 18) primarily to be the leader of the bridge reconnaissance team organized by the Earthquake Engineering Research Institute. The EERT, which is headquartered in the Bay Area, was assembling teams of experts to do reconnaissance work, not just for bridges, but to survey the damage in buildings and assess emergency response, for the purpose of writing a reconnaissance report for the benefit of all of those professions associated with earthquake engineering.

My responsibility at that time was to lead the bridge reconnaissance team. That team varied in size between 10 and 20, and we surveyed approximately 24 bridges which were identified to us by Cal Trans to either have sustained the most damage or to appear to be in the most critical condition. That preliminary survey is now complete, and the preliminary reports are currently being written.

But whilst I was there I was asked by the Governor of the State if I would head up an independent commission into the inquiry, particularly, of the Cypress Street viaduct.

Senator **Moynihan**. Is that what we have been referring to as the Nimitz?

Mr. **Buckle**. Yes. I'm sorry. This mile and a half elevated structure parallels Cypress Street and has been called and should, I believe, be correctly called the Cypress Street viaduct. It will prevent confusion with other structures on the Nimitz Freeway.

Senator **Moynihan**. Engineers have a tendency to be precise, which you will not encounter much of hereabout.

Mr. **Buckle**. Thank you.

There is no doubt, Mr. Chairman, that the collapse of the Cypress Street viaduct is a catastrophe of the greatest proportions. It is always difficult to make absolute superlatives, but I do not know of any other bridge collapse, due to an earthquake, where this number of people have been killed. It will be the center of attention not just nationally, but also internationally. The reasons for the collapse are several and it is important that we define them: the sequence of the collapse, what triggered the collapse, the state of the art at the time the bridge was designed; the events since that time to bring the bridge up to code, because some retrofit had been conducted on the structure since its completion in the late 1950s. The effectiveness of these retrofit measures will be studied, of course.

Mr. Chairman, arm wrestling with nature, as engineers do with earthquakes, is not for young players, and it is to be done with a great deal of care. The forces involved are enormous. We cannot duplicate these forces in our laboratory. We have an earthquake simulator at U.C. Berkeley. We have one at the University of Buffalo. The Corps of Engineers has an earthquake simulator. But we have to understand that these simulators are, themselves, quite small in terms of their power capacity. We cannot come close to the amount of energy released in an earthquake of this size. Therefore, the process of learning is somewhat hampered by the fact that when we have a theory we can't test it.

So we progress by consensus of professional opinion. We look at Mexico City, we look at Armenia, and we look at earthquakes in Japan and we attempt to learn.

We have developed theories. We develop code provisions. We implement these because we don't have the time to wait for the next earthquake to test the theory.

We will learn a great deal from this particular event—particularly concerning the behavior of an old structure—and by this I mean a pre-1975 bridge—on soft ground. The bridge is located close to the Bay where the surface conditions are considered to be poor. I'm sure that we will learn in time that a factor in the collapse of other structures in the Bay Area, like in the Marina District and the Bay Bridge, was also the soft ground on which these structures have been built.

The soil structure interaction problem is a notoriously difficult one to quantify for engineers. I am convinced that from the structural damage in this earthquake, and particularly at Cypress, that we will learn even more about the design and the retrofit of older structures, pre-1975 bridges, and their performance on the softer soil.

The reason for mentioning 1975 is that 1971 was the year of the San Fernando earthquake, in which a number of new bridges collapsed. That was a turning point in the way bridges were designed in the State of California—new structures, ones built from about 1975 when the new codes were issued, have performed, and we expect them to perform a great deal better.

The problem that we see here is the upgrading of the old structures to the codes which were revised in the mid 1970s.

Bridge retrofit is not just a California problem. If I have a message to the committee, it is that it is a national problem.

Senator MOYNIHAN. A national problem?

Mr. BUCKLE. A national problem because earthquakes are not unique to California.

Senator MOYNIHAN. Doctor Ahmad is agreeing.

Mr. BUCKLE. We know there have been great earthquakes outside of the State—specifically in the Mississippi Valley. There were several catastrophic earthquakes in 1811 and 1812.

Senator MOYNIHAN. There was an earthquake in Missouri that rang church bells in Boston.

Mr. BUCKLE. Exactly. We know that——

Senator MOYNIHAN. And the Corps of Engineers was on hand.

Mr. BUCKLE. And we know that Charleston not only suffers from hurricanes of devastating proportions, but also 103 years ago it was the scene of a devastating earthquake.

We know from studies that have been done—recent studies—that the potential for a damaging earthquake magnitude six or greater is very real in the Eastern/Central United States. If we can learn another lesson from California, it is that the Californians are prepared for this kind of event. They have had codes which have required earthquake loads to be considered. If we look at the East and Central United States where this magnitude of earthquake is a reasonable expectation within the next 30 years, we are not prepared. We do not have seismic design provisions in either our bridge or building codes. We can expect to see the Cypress Street disaster repeated unless we do something about it.

And we have to do something about it. We have to accelerate the bridge retrofit program. We have to encourage the other State departments of transportation to elevate it in their list of priorities, and the funding has to be available to do this and to do it quickly.

Thank you for the opportunity to make this statement.

Senator MOYNIHAN. Well, that was characteristically concise. Don't move. We'd like to hear from your colleague, Doctor Ahmad, and then I know we'll want to pursue this further.

Doctor, we welcome you to this committee—I think for the first time, also.

STATEMENT OF JAMEEL AHMAD, CHAIRMAN, DEPARTMENT OF CIVIL ENGINEERING, COOPER UNION COLLEGE

Mr. AHMAD. Thank you very much.

I thank you for giving me the opportunity to appear here and perhaps focus on some of the issues a little bit more from the research and development point of view—some of the newer technologies which are available.

First of all, as has been clear from the experience in the 1971 earthquake in the San Fernando Valley and the current earthquake in San Francisco, our buildings have performed well during the earthquakes and this is really not due only to the fact that we are lucky, but there are several reasons for it.

Number one, buildings are localized structures. They are grounded in the ground foundations, but they are vertical structures. The expanse is not as large as bridge structures are or as are pipelines or sewer lines. So you have more vulnerability for the infrastructures in an earthquake, which is a massive shakedown type of test which nature imposes on us—rudely, I might add. So we have greater potential for damage.

Now, I will shift the scene perhaps to New York City, where I have lived for the past 25 years. I did get my education in earthquake engineering by living in Hawaii for many years in the early 1960s.

In New York City we have, again, the likelihood that a strong earthquake could happen. This cannot be ruled out. We talked here about modern structures as opposed to old structures, with the implication that the modern designs incorporate better earthquake resistance criteria than the older designs.

We have in New York some truly old structures. The water supply for the entire City of New York and the five boroughs comes from upstate reservoirs. This water is delivered to the City of New York through two huge water tunnels. These water tunnels run under the ground 250 feet below grade, and they are 15 to 20 feet in diameter. These bring our water supply to us. Can you imagine the consequence of a strong motion earthquake?

The two water tunnels have been in service for—well, the second one, which is the more modern one, was opened in 1926. So you can imaging how old these structures are. They have been supplying water nonstop without any closure for at least 75 years. There was an attempt to close one of the tunnels to inspect the lining and see if there is any damage, and it was not possible to do so because the valve structures to close these tunnels are so old they were afraid that they might break. So these two tunnels have been running since that time.

There is currently a third water tunnel under construction in the City of New York, but the estimates are that this might take well into the next century to complete.

Senator **Moynihan**. May I just interrupt there to say that I'm glad you mentioned the age of the first and the second tunnels. That second tunnel was the first true aqueduct built since 4th century Rome. It happened to be an underground aqueduct, but the engineering was basically the same and just as audacious. And this was done in the bad old days of Tammany Hall. I just wanted to get that on the record.

Go ahead.

Mr. **Ahmad**. There are estimates based on actual metering of the water that we are losing more water in these two tunnels through cracks and through other localized failures. Enough water to meet the entire water supply of the City of Minneapolis is lost in these tunnels.

Senator **Moynihan**. Just a leaky system.

Mr. **Ahmad**. Yes.

Senator **Moynihan**. That's why the third tunnel is underway.

Mr. **Ahmad**. Another example is our subway system in New York, which was constructed at the beginning of this century, so it is even older.

We have water mains which are very old. We have gas mains. We have recent examples in New York City where failure of water mains and gas mains is a very common phenomena. We have perhaps one water main breaking a week flooding the subways and all the rest. These are very, very old systems.

So when we are talking about the infrastructure, we are talking about behavior under service conditions. There is no earthquake which has caused this type of damage.

We also have problems with our bridge structures. The two-tiered structure—the Nimitz Cypress viaduct—is, in effect, a copy of the design which was earlier constructed in New York, the FDR Drive. This is a two-tiered structure that was built in the early 1940s, and the design was of that vintage and was then moved out to California.

Senator **Moynihan**. That's a nice thing to get a little historical fix on. The Cypress Street viaduct is basically the design of the East Side Highway named for President Roosevelt after he died, which probably would have been designed under Moses, wouldn't it have been?

Mr. **Ahmad**. That is correct.

Senator **Moynihan**. The interstate highway program was proposed by Moses and picked up on.

Senator **Reid**. Moses, he's really old.

Senator **Moynihan**. Senator, Senator.

The reporter did get that, didn't he?

So these things have names, and there are people associated with them.

Mr. **Ahmad**. That is correct.

We have our sewer system, gravity sewers, which are also very old, dating back to 1924 when the first water pollution control treatment plants were built.

Now, if we have an earthquake of this magnitude in New York, which cannot be ruled out—as a matter of fact, I'm not a seismologist, but I am aware that there are three faults that run in New York in Upper Manhattan—one right through the Inwood section, which is the northern tip of Manhattan. So there are three faults that go through New York and we cannot rule out the occurrence of an earthquake.

So perhaps what we really have to look at is our approach to infrastructure rehabilitation, when this term is used, basically the term is used in the sense that we have an older structure which is falling apart and we put it back into service condition. But I think that we need not only just replacement engineering, but perhaps upgraded engineering. Once you build these structures and replace these structures you will not have an opportunity for the next 50 years or so to upgrade them. So as an example of the infrastructure—not just bridges, but other structures—you can imagine if, in a strong earthquake, we lose one of the water tunnels.

I participated in a study which was done in New York City to look at the consequences of the failure of a second water tunnel. What will happen is that 50 percent of the population of the City of New York will be without water. It is bad for the drinking water, but imagine not being able to flush the toilets. When the water supply goes, it is also the same water we use for wastewater purposes.

Senator MOYNIHAN. You'd have a massive public health problem on your hands.

Mr. AHMAD. It is an unimaginable disaster that can happen.

Senator MOYNIHAN. And this would be true in Chicago?

Mr. AHMAD. Absolutely.

Senator MOYNIHAN. Boston?

Mr. AHMAD. Everywhere.

Senator MOYNIHAN. Atlanta?

Mr. AHMAD. So I think what we really need to realize is that although our buildings and our bridges are important, we have a massive system of infrastructure—conveyance of water, conveyance of wastewater, conveyance of gas, conveyance of steam which is done in Manhattan, for example. Con Edison has a massive steam line. We need to look at the entire infrastructure.

I think for your committee, Mr. Chairman, which has jurisdiction over this, I would like to make a couple of recommendations not in terms of actual legislation, but just from the point of view of the research and development potential that exists and some of these systems which are being developed and perhaps we should cut through the red tape a little bit more than we have done. As was pointed out earlier, bureaucracy has been wonderful in implementing some of the codes and some of the procedures, and it has resulted in higher cost of construction.

Senator MOYNIHAN. Senator Reid's point.

Mr. AHMAD. Yes, sir. But I wish to point out that there are and continue to be obstacles in the implementation of newer technologies, and we need to circumvent that.

For example, there is a new field in earthquake engineering. We have a field for active control systems. What this means is that most of the retrofit work we are doing is in the passive control. In other words, these are the——

Senator MOYNIHAN. Passive control?

Mr. AHMAD. Active control. An example of an active control is the Citicorp Building in New York. On top of that building sits a 400-ton weight of concrete which is floating on a layer of oil. It is not connected to the mainframe of the building, but as the building sways this acts as a damper. It helps to cut down on the larger deflection. Currently, this——

Senator MOYNIHAN. A lay mind would think just the opposite.

Senator REID. Floating on oil?

Mr. AHMAD. Yes. In other words, this is a free-floating thing. The building sways one way, and the mass of concrete does not go with the motion of the building. It catches onto the side of the building and because of that impact——

Senator **Moynihan**. Oh, there's only a very slight friction to bring the—the oil doesn't move; therefore, the concrete doesn't move much.

Mr. **Ahmad**. That's right. And there is damping action that cuts back on the——

Senator **Moynihan**. Yes.

Mr. **Ahmad**. This is an example of an active control system. Now, this particular mass of concrete is computer controlled so that, based upon the sensing of the motion of the building, a computer moves, through hydraulic actuators, this mass so that it brings the building back very quickly to its shape. This is a concept of active control system.

Senator **Moynihan**. Whereas TransAmerica would be a passive control?

Mr. **Ahmad**. Yes. We can——

Senator **Moynihan**. So, once again, New York is ahead of San Francisco.

That keeps coming up.

Mr. **Ahmad**. I really appreciate this opportunity to explain to U.S. Senators something about my field in buildings. If you look at the building design, a building is a structure which is designed once and then left alone to respond to all sorts of loading phenomenon. It does not have the capability to call upon any reserve in it—just like the human body. If we have some loading, we always have the ability to adjust ourselves a bit to prepare for the shock. If I see a slap coming for me, if I move away a little bit it softens the blow. If I move into a slap it amplifies the blow.

It is with this concept that some of our structures can be designed so that they are intelligently, artificially, computer controlled to soften the blow. This field is quite well developed. We have devices out there where this can be implemented, but there is more need to get this type of work into the actual experience so that we can get the proper data that we need.

There are also vibration isolation systems, which are things that can be attached to the foundations of structures, and these soften the ground motion. Instead of transmitting the shock of the ground movement to the building, they can soften it. They are sort of like shock absorbers in your car. If you wish, we have all those buildings and bridges that are like a car which has no shock absorbers. The blow is not softened in any way. And there are technologies like this which can be even retrofitted in bridge structures.

Senator **Moynihan**. The basic point is that there is no such thing as stationary, is there? Everything is moving?

Mr. **Ahmad**. Yes.

Senator **Moynihan**. There is a frequency to a bridge, a frequency to a brick, I suppose. I guess the physics, Doctor Buckle, is that what happens in an earthquake is the equivalent of plucking a guitar string. Suddenly that frequency resonates at much greater——

Mr. **Buckle**. If I might just break into this discussion, because it is a field of particular interest to me, and it also answers your question as to why the 60-story building survived and a 2-story structure collapsed. When you pluck the guitar string, it has a certain frequency content, just as earthquakes have dominant frequencies. If the building or bridge has the same frequency as the guitar string, then it gets excited by the earthquake and amplifies it and you have damage. If the building or bridge does not have the same frequency as the guitar string, it will be immune to it. It won't even notice the passage of the earthquake. And 60-story buildings do not have the same frequency as earthquake strings, nor do suspension bridges like Golden Gate.

It was mentioned earlier that the reason why 60-story buildings stand up is because they are modern. Well, true. But the principal reason is because they have a different frequency of response.

You could ask why traffic was on Golden Gate Bridge the same evening but these structures were down? Here it is not a question of age; it is a question of response frequency. Basic fundamental dynamics explains their difference in behavior. Short structures like the Cypress ones collapsed because they are in harmony with the guitar string.

And the trick of passive isolation or passive control is to trick a short-story building into thinking that it is a 60-story building. That's what the isolation——

Senator MOYNIHAN. That's a wonderful phrase. That's quite a phrase. If we could just get that 2-story building to think big——

Mr. BUCKLE. And, indeed, there was a bridge close to Candlestick Park which is isolated in this manner that Doctor Ahmad is speaking of as a retrofit measure, and it survived the earthquake without scratch. So it is a very promising technology.

Senator MOYNIHAN. So what we have learned from this panel is that there is a lot of science and engineering that has been going on that we could start using in ways that we haven't done—just the idea of an active defense.

I'd like to ask, first of all, our colleagues—we have to be out of here in nine minutes. I want to get to some thoughts on national codes which Doctor Buckle, Doctor Ahmad, and Doctor Zensinger might have. I know the Association of State Highway and Transportation Officials does try to produce some uniformities, but this issue has come up. But first, Senator Reid, you've been so thoughtful to be here all morning.

Senator REID. I'll take my three minutes and be as quick as possible.

Doctor Buckle, I tried all weekend to find out what the seismic activity was at Yucca Mountain, and I think I'm getting the run around because there has been an acknowledgment by the National Earthquake Center in Denver that there was some, but they don't know how much. Is there any way that you could find out what that was at Yucca Mountain?

Mr. BUCKLE. Yes, I could.

Senator REID. Would you let me know at your convenience, or have somebody in your office——

Mr. BUCKLE. I'll have somebody in my office call.

Senator REID. I would appreciate that very much.

Senator MOYNIHAN. Will that come to you courtesy of the State University of New York at Buffalo?

Just let that be recorded.

Senator REID. The difference in the destruction in Armenia compared to San Francisco—I'm sure the terrain is different, and all that, but wouldn't one of the reasons be the way the buildings were constructed?

Mr. **Buckle**. Very definitely. There is some similarity with the soft soil issues, but the pre-cast structures in Armenia are detailed in a fashion that is not permitted in the high seismic zones of this country. And, indeed, it is not possible to build one of those structures in the State of California as of this time because they are known to be high-risk structures.

Senator **Reid**. I have here a map that shows seismic activity in recent years in the State of Nevada—and there are earthquakes all over not from the San Andreas fault, but the Olinghouse Fault, Carson, Walker-Lane Fault, Northern Death Valley Fault, Fish Lake Valley Fault, Sierra Nevada Frontal Fault Zone. I think that one of the things that we need to do—and maybe the State of Nevada will have to do that on their own—is get an idea from earthquake specialists as to what the long-term effect is in the State of Nevada for seismic activity. It appears that these earthquakes which run anywhere from 7.6 to 6.3 over the last few years—when I say last few years, from the early 1920s.

I know we are in a hurry, Mr. Chairman. I'll be very quick.

One of the things that I——

Senator **Moynihan**. Senator, take your time. You've been here all morning.

Senator **Reid**. One of the things that I would ask Mr. Zensinger to do is: I think one of the real misconceptions of what FEMA is empowered to do and can do is the fact that people find—there have been 6,000 applications, but I think the key is: applications for what? FEMA is limited in what you can do to help people, isn't that right?

Mr. **Zensinger**. Sure.

Senator **Reid**. What can you do to help people?

Mr. **Zensinger**. To help individuals, the application will provide for temporary housing for both owners of houses or renters. It will provide for grants for individuals who cannot qualify for loans of up to $10,400 to meet immediate needs and necessary expenses. It will provide for getting into the SBA loan process—this application which is taken. SBA loans are for those people who have the financial capability to repay a loan, and there is an income test which is administered.

In addition, we have assistance for unemployment. If someone is self employed and doesn't have access to an unemployment program administered by the State, they can get disaster unemployment assistance. There is legal counseling. There is mental health counseling. There are a number of other programs like that.

The basic financial programs, however, include assistance for temporary housing and the individual grants for people who do not qualify for loans.

Senator **Reid**. Based on this brief statement, it is certainly apparent that the people in California, in spite of FEMA—and I'm sure that you're going to do the best that you can—I heard figures, Senator Wilson, that only about 10 percent of the people had their homes insured for earthquake damage, so there is significant hardship that is going to take place in California that we don't imagine.

Senator Moynihan, I'm not going to take more time other than to say that this is an outstanding panel. The simple fact, Doctor Ahmad and Doctor Buckle, that we haven't asked you more questions doesn't take away from the brilliance of your presentation. I think it has been very concise and forthright.

I think, Mr. Chairman, some time in the future when we have more time we could have these men come back so that we could spend more time.

One parting comment. Doctor Buckle said we have to accelerate our work on the bridges. It is pretty hard to accelerate nothing. We are really not doing much.

Senator **Moynihan**. Yes. If you multiply 10,000 times 0 you get 0, and 100,000 times 0 is 0. That's about all the algebra I have lest.

Senator Wilson, would you like to ask any questions?

Senator **Wilson**. Yes. Mr. Chairman, mindful of the time I will just read into the record some questions for the members of the panel, not in the ordinary sense, because I really would love the answers, and I'd love to get them as quickly as I can.

First, for Mr. Zensinger, with respect to three possible changes in the law, one having to do with the problem of the rebuilding of those structures in Santa Cruz that have fallen down, I understand that many of them are in a flood plain. The question is: does the law interpose any kind of impediment because of that fact?

Second, with respect to the urgency of the need of the recipients of disaster assistance, should we not change the law as it relates to the verification requirement so that we do not have the delay that it occasions presently?

Third, I would be grateful if you could indicate to the committee and to my office under precisely what circumstances the 25 percent local share for FEMA funds is waived with regard to such things as increased operation of ferries and other substitute forms of transportation.

With respect to Doctor Buckle, let me just ask this: is the obvious, inherent danger in a double-decker freeway system so great that it defies any state of the art? Or is it possible, either through retrofitting or through the construction of new structures, to make use of the double decker system to deal with problems of congestion and still do so safely?

Second, could you advise the committee as to the comparative costs and comparative effectiveness of retrofitting as compared with new construction. I take it, by the way, that the comments that you were making with respect to bridges apply to elevated freeways, as well.

Third, I would be very interested whether, in your survey of bridges in the Bay Area that you just conducted, this reconnaissance, whether you found any damage so severe that we can anticipate the closure of other bridges, and specifically those that are going to be relied upon as alternatives to the Oakland Bay Bridge while it is closed.

Fourth—and this is really a question for both you and Doctor Ahmad—you made the statement that there are limitations on the ability to test one's theories, and that made me think of the fact that both at Buffalo and Berkeley you have and they have shaking tables. Is it not possible to take that out in some isolated place and really crank it up to full volume and test the theory so that you can simulate what would be an 8.3 on the Richter scale?

Mr. **Buckle**. At scale. You could do it at half scale. You could put a magnitude 8.3 through a half scale or model structure, but putting an 8.3 through a full-scale structure requires more energy. At this point in time the only people I know who can do it are the Japanese.

Senator **Wilson**. One of the questions I wanted to ask you is: what is the state of the art in Japan? But you might want to advise the committee of that since God knows they are earthquake prone.

[The following is in response to Senator Wilson's question:]

Significant technolgical advances have been made in the development of flexible, chemically resistant materials for pipes. These materials have a superior structural performance under dynamic loads than conventional materials such as cast iron and concrete. For example, high-density polyethylene pipes are strong, flexible and chemically resistant; such pipes are being used increasingly for underground applications. Another significant advance has been the development of flexible joints which are capable of withstanding dynamic loads such as those due to an earthquake. Further research and development work in both materials and design criteria is needed to advance the state-of-the-art in this important field.

Senator **Wilson**. The final question had to do with the comment that was made very eloquently by Doctor Ahmad when he spoke of the undergrounding of utilities—of major water lines and other things—in New York and elsewhere. What has been the advance and the state of the art with respect to replacing materials that seem to me especially susceptible to quake damage? Must we continue to rely upon metal or concrete pipe? Would it not be possible to devise a flexible material tough enough to withstand corrosive and other pressures from the earthen surroundings and, at the same time, flexible enough so that it would not break under these sharp jolts that are received from a quake?

Senator **Moynihan**. Good questions. And thank you very much, Senator.

Thank you, gentlemen.

It is very clear from Senator Reid's remarks that we are going to want to stay in touch with Doctors Buckle and Ahmad. We are obviously already in touch with Mr. Zensinger. Those were absorbing comments, and as we move forward to some general legislation we are going to stay in touch.

We thank you both for coming down. We thank our audience. I'd like to acknowledge the presence of Nancy Rutledge, who was such a champion of this enterprise as Executive Director of the National Council on Public Works Improvement.

Again, thank you all.

The hearing is closed.

[Whereupon, at 12:30 p.m., the subcommittee was adjourned, to reconvene at the call of the Chair.]

[Statements submitted for the record, responses to additional questions, and the bill S. 1775 follow:]

TESTIMONY BY

THE HONORABLE PETE WILSON
UNITED STATES SENATOR (R-CA)

BEFORE THE

SUBCOMMITTEE ON WATER RESOURCES, TRANSPORTATION, AND INFRASTRUCTURE

OCTOBER 23, 1989

HIGHWAY EMERGENCY RELIEF FUNDS LEGISLATION

Mr. Chairman:

I am pleased to be here this morning, and I want to thank you for holding this very timely hearing. On Friday morning, I had hand delivered to you and Senator Symms a letter asking that the Subcommittee conduct a series of hearings to examine how we can ensure the integrity of our Nation's infrastructure in light of the tragic earthquake last Tuesday in the Bay Area, a copy of which I would like permission to enter into the record.

Let me start this morning first by noting that I was in San Francisco, on the thirteenth floor of a large building, when the quake hit. It was not the first time I had been in an earthquake by any means, but I have never experienced a more terrifying one. This was a violent, shaking quake, not the rolling kind which so many Californians have experienced. It seemed to last for five minutes, not for fifteen seconds. And, due to the loss of communications, we in the Bay Area did not fully understand the quake's ramifications until late in the evening, or even the next morning.

For the most part, the public's attention has revolved around two transportation structures whose collapse symbolize the quake's devastation: the Bay Bridge and that unbelievable portion of I-880, the Nimitz Freeway. In traveling last week with President Bush, Vice President Quayle, and twice with Secretary Skinner and Governor Deukmejian, I can confirm your impressions about the disaster. The collapse of Route 880 has to be seen to be believed, and even then it is difficult to comprehend. The pillars supporting the second deck of the Nimitz Freeway utterly collapsed. Where there was once a twenty foot space between levels, there is now less than twenty inches, and in some places virtually none. We still don't know how many lives were lost in the tragedy on the freeway. The Bay Bridge appears to be in better shape structurally, with only one section of the upper deck having collapsed.

What has not been discussed to any great extent by the media, though I have spoken with federal, state, and local officials about it, is the viability of the Bay Area's transportation infrastructure exclusive of the Bay Bridge and the Nimitz. Clearly, both the federal Department of Transportation and FEMA will be called upon to aid in repairing scores, if not hundreds, of roads throughout the Bay Area, from Santa Cruz to the East Bay.

Now, let me turn to the legislation Senator Symms introduced on Friday on my behalf, and that of Senator Burdick, Senator Chafee, and Senator Dole (S. 1775). I want to stress, as Senator Symms stressed on the Senate floor at its introduction, that this legislation is a working document-- a first attempt to utilize the Subcommittee's expertise in this area.

The bill, though necessarily preliminary, is a very useful beginning. It accomplishes several important goals. It lifts the $100 million per disaster cap on emergency relief funding and authorizes the Secretary to expend such sums as necessary to rebuild the affected infrastructure, and it holds California harmless in ensuring that emergency relief funds do not apply to its 85% minimum allocation.

Passage of these provisions is essential to ensure that California's damaged infrastructure will be repaired as quickly and as efficiently as possible.

However, there are two notable deficiencies in the bill. First, the bill makes no change in current law which forces such emergency repairs to be completed within 90 days for the State to receive 100% federal reimbursement for those repairs. Clearly, there is no way that the state and local public works personnel can make whole again the devastating effects of the earthquake that quickly. Not even a full assessment of the damage and its costs has been completed at this time, indeed, an accurate assessment may invovle weeks.

Second, while the bill allows the Secretary to expend funds to repair the Bay Bridge (funds for which the Bridge may not be eligible under current law, as it is a toll bridge and was not built with federal funds), the bill limits such reimbursement to the difference between the bridge's insurance repayment and the actual cost of repair. I discovered last Friday, when talking with Representative Mineta in San Francisco, that the State has insured not the bridge structure itself, but the toll receipts. To further complicate the matter, the Bridge's toll revenues ordinarily are shared by local Bay Area transportation projects.

Therefore, not only does the State not carry earthquake structural damage insurance for the bridge, but any change in the toll payment structure will affect other portions of the Bay Area transportation infrastructure at a time when all Bay Area transportation modes and projects need as much assistance as possible.

I believe that the Congress and the Administration can work together, and will work together, to resolve these problems. The House Appropriations Committee this afternoon plans to mark-up a transportation funding bill which will include $1 billion for such repair and reconstruction, will extend the 90-day period to 180 days, and will make Bay Bridge repairs eligible for full reimbursement. I look forward to working with you, Senator Symms, and all Committee members to resolve these issues on California's behalf.

In addition, while there simply is not available an accurate estimate of the cost of repairs at this time, we can reasonably expect increased costs in other portions of the Bay Area's transportation infrastructure. BART, which runs along the East Bay and from Oakland to San Francisco, will increase the frequency of its trains to relieve vehicular traffic during the repair period. Extra trains and extra hours add up to extra wages and operating costs for BART-- overtime costs alone probably will force BART to request federal reimbursement. San Francisco's Muni rail system may face the same problem. The Governor has suspended toll service on all Bay Area bridges, and ferry service across the Bay (though privately funded) has increased dramatically since the earthquake.

In sum, Mr. Chairman, the Bay Area has experienced a devastating disaster whose primary affects on its transportation infrastructure are just now being discovered, and whose secondary ramifications have yet to be determined. With viable cost estimates of repairing either primary or secondary damage simply unavailable at this time, the Senate is faced with a major challenge to ensure adequate and equitable reimbursement to the State.

Repairing the damage to the Bay Area will take a coordinated and well-planned effort, engaging the talents of both the Executive Branch and the Congress. I am very happy that the Senate is now preparing to take action in this regard. I believe that your Subcommittee's support of emergency relief funds legislation will ensure Californians that the Senate will work in cooperation with the House and the Administration to rebuild the Bay Area's complex and vital transportation network.

Again, Mr. Chairman, thank you very much for holding this important hearing, and I look forward to working with you and Senator Symms in the future to examine the long-term implications of last week's tragic earthquake.

Statement of Thomas D. Larson
Administrator
Federal Highway Administration
U.S. Department of Transportation

Hearing before the Subcommittee on Water Resources,
Transportation, and Infrastructure
Committee on Environment and Public Works
United States Senate

The Northern California Earthquake
of October 17, 1989

October 23, 1989

I would first like to thank the Committee for the opportunity to testify today on the Northern California Earthquake of October 17, 1989 and its effects on highway transportation in general, and about S. 1775, introduced by Senator Symms on October 20, 1989 in particular.

As you are aware, President Bush, Vice President Quayle and Secretary Skinner visited the San Francisco area in the aftermath of the earthquake. One purpose of these visits was to begin an immediate assessment of the funding requirements to promptly repair the area's transportation systems. The main focus of attention today is the availability of emergency relief highway funds in FY 1990 and the potential elimination of legislative restrictions on their use.

It will be several weeks before accurate estimates are available of the cost to repair I-880, other freeways and federal-aid highways, and the Bay Bridge. Expanded interim ferry service will also be required.

The major source of highway funding for emergency repairs is the Federal-aid highways emergency relief program. At this time, $220 million is available in FY 1990, including prior year carryover funds and adjusting for sequestration. This is a nationwide source of funds. However, as the Committee is aware, there are several statutory restrictions at the present time on the use of emergency funds. These include:

- obligations cannot exceed $100 million per State per disaster;
- obligations cannot be made for toll facilities (e.g., Bay Bridge); and
- federal share may be 100 percent for emergency restoration of traffic during the first 90 days, then normal state and local cost sharing is required.

California will also receive approximately $900 million in formula-allocated highway funds in FY 1990 in categories that would be eligible for use in restoring bridges and highways on the Federal-aid system in the San Francisco area. However, this funding is available in a series of specific categories which have limited correlation to the damage. It is likely that California would make available to the Bay Area at most $300 million of its Federal-aid allocation and approximately $150 million in State and local funds. Of course, shifting funds beyond what was already planned for the San Francisco area would also disrupt ongoing road programs elsewhere in the State.

One additional complicating factor in determining available emergency funds is the need to cover outstanding claims for Hurricane Hugo's damage. Although no formal request has been received, FHWA expects highway claims on the order of $50 to $70 million for South Carolina, the Virgin Islands and Puerto Rico.

The Department of Transportation is responding fully and promptly to the tragic events in California.

Specifically, the Department is undertaking the following course of action:

- Secretary Skinner has already announced that FHWA will make $100 million in emergency relief highway funds immediately available to California as the State applies and submits claims in an expedited process. The California Department of Transportation transmitted a letter of intent to request funding, and FHWA has assured California of immediate action.

- The Administration will work with Congress and California in support of an appropriate increase in FY 1990 for Emergency Relief (either as direct appropriation or contract authority), specifically to aid California. It is important that any new funds provided for California not be subject to the $100 million per State per disaster limitation in order to put the additional funds to full use.

- Given the importance of restoring the Bay Bridge to facilitate traffic in the area, we will also carefully review the repair costs of the Bridge and the State's provisions for insurance on the Bridge, to determine the residual cost that could be funded from Emergency Relief if Congress waived the toll road prohibition affecting such funds.

Of course, we are ready at all times to work with the Committee and the entire Congress to produce legislation to aid California.

Senator Symms' bill addresses some of these issues. It provides for Emergency Relief Funds from the Highway Trust Fund specifically for the damages suffered from the earthquake by providing such sums as may be necessary.

- Such sums would have contract authority and be immediately available for obligation;

- they would not be subject to any obligation limitation (consistent with current law);
- they are exempted from the $100 million cap per State, per disaster; and
- they could be expended for damages on the Bay Bridge after the application of insurance payments.

While we strongly support the general goals of S. 1775 to provide needed relief to California, which are consistent with the Administration's actions, we oppose open-ended commitments of Highway Trust Funds. Moreover, an accurate and complete assessment of the needs of California has not been made. Six technical teams of FHWA and State officials will begin the detailed assessment of needs tomorrow. We expect this effort to be completed in 6 to 8 weeks.

Mr. Chairman, at this point I would like to turn to the subject of earthquake protection standards.

CURRENT BRIDGE DESIGN CRITERIA

Since the 1971 San Fernando earthquake, the Federal Highway Administration has funded numerous research projects to improve the seismic design of bridges. These culminated in a contract to the Applied Technology Council of California to compile a new set of Design Guidelines based on the results of this research. Published in 1981, the ATC-6 Seismic Design Guidelines for Highway Bridges were adopted by AASHTO in 1983 as "Guide Specification for the Seismic Design of Highway Bridges". These specifications represent the state-of-the-art in seismic design for bridges and are recommended for the design of all new bridges throughout the United States.

Alternately, the criteria in the AASHTO Standard Specifications may be used in the United States. These were also substantially modified following the 1971 San Fernando earthquake and the revisions first appeared as Interim Specifications in 1975.

The Caltrans criteria for the seismic resistant design of highway bridges were also rewritten post-1971 and in many respects are similar to the AASHTO Guide Specifications. The current design criteria requires a dynamic analysis of bridges in earthquake zones and requires that bridges be designed to resist specific dynamic forces and be able to safely accommodate specified displacements at points where the structure is not continuous.

BRIDGE RETROFIT

Design requirements for retrofit of existing bridges are the same as for new bridges. That is, when an existing bridge is evaluated for possible retrofit, the same dynamic analysis and earthquake resistance capability must be provided.

States and other bridge owners in earthquake-prone areas have considered the need to retrofit existing bridges as one of the many priorities for bridge safety improvements. States such as California have undertaken a comprehensive program within available fund limitations. Other States which have not experienced a damaging earthquake in this century have placed a much lesser priority on retrofit.

ASSESSMENT OF THE PROBLEM

Generally, the existing bridge design specifications are adequate for the design of new bridges and retrofitting existing bridges. However, as additional experience is gained and research is completed, appropriate adjustments in the design requirements will be made.

As researchers improve their knowledge of the probability of actual forces and displacements likely to be caused by earthquakes, design codes will be adjusted.

That concludes my statement, Mr. Chairman. I will be pleased to answer any questions.

National Center for Earthquake Engineering Research
State University of New York at Buffalo

November 15, 1989

Honorable Pete Wilson
United States Senate
Washington, D.C. 20510-0502

Dear Senator Wilson:

During the question and answer period following testimony given to the Subcommittee on Water Resources, Transportation and Infrastructure on October 23, you read into the record four questions for my attention. I offer the following responses:

1. Seismic safety of two-level, elevated freeway structures

   The danger of collapse of a double-decker viaduct is no greater than that for a multi-story parking building and other highrise structures with heavy contents. However, their unusual length and narrow width does put these structures in a class of their own, but the state-of-the-art exists to design them in accordance with the philosophy of modern seismic codes. This philosophy emphasizes life safety; which means that collapse, even in a great earthquake, must be prevented. Damage to the columns should, however, be expected and demolition may be necessary if column repair is not feasible. However, the safety of the travelling public should be assured by the avoidance of structure collapse.

   Since the mid-1970's significant advances have been made in the design of concrete bridge columns, and the above objective is now attainable without an unreasonable increment in cost. The same philosophy is also used for the design of reinforced concrete buildings.

2. Comparative costs of retrofit vs. new construction

   In most cases a complete bridge retrofit will involve tying the spans together at the supports and hinge seats, jacketting the columns and strengthening the foundations. Since a complete retrofit has yet to be attempted no reliable cost data is available. The Caltrans program, to date, has concentrated on tying spans together. Column strengthening is about to commence, and foundation retrofit is still in the R and D stage. One rough estimate is that retrofit is about one-fifth of the cost of a new bridge, but this figure could be in error by a factor of 2 depending on the number and type of deficiencies in the bridge.

3. Reconnaissance report of bridge damage

   I enclose a copy of my preliminary reconnaissance report submitted to the Earthquake Engineering Research Institute on behalf of my team members. A detailed report is due to be submitted before Christmas.

Red Jacket Quadrangle, Buffalo, New York 14261 Tel: (716) 636-3391 FAX: (716) 636-3399

4. State-of-the-Art in Japan

Bridges in Japan have also suffered damage from earthquakes. Some of the most detailed descriptions of bridge failures in earthquakes can be found in the Japanese literature. In fact, more bridges have collapsed in Japan, due to earthquakes, than in the United States but I hasten to add that destructive earthquakes occur more frequently in Japan than in the United States. Bridge researchers and designers from the US and Japan meet annually to exchange experience and research data. Such meetings have proven beneficial to both sides and have illustrated, amongst other things, the resourcefulness of US bridge engineers despite limited resources and test facilities. For your information I enclose a table of large scale experimental test facilities in the United States compared to those available in Japan. It is clear that test facilities in Japan far exceed those available here in the US. However, the important point to note is that high quality facilities alone do not necessarily lead to high quality research. Good people are equally important. So far the US has maintained an edge in the field of short- and medium-span bridges because competent people have been at the forefront of this work. However, it is proving more and more difficult to attract bright young people into this field because facilities are deteriorating and resources are shrinking. The balance has now swung in favor of the Japanese and I expect to see them pull ahead in this field also -- they already dominate the long-span suspension and cable-stayed bridge field.

We need an aggressive policy of refinancing and restructuring our Civil Engineering Schools to meet this challenge -- not only to stay ahead of the Japanese but also to avoid repeating the tragedy of last October 17.

Thank you for the opportunity to respond to your questions. If I can provide further information please do not hesitate to ask. I enjoyed our brief meeting following the hearing on October 23. I shall look forward to working with you and your staff in whatever manner is appropriate.

Sincerely,

Ian Buckle

Ian G. Buckle
Deputy Director
National Center for Earthquake
Engineering Research

IGB:ii
Enclosures: Preliminary report
Table

cc. Mr. Paul Chimes, Editorial Director
Committee on Environment and Public Works

Reconnaissance Report
Bridge Structures
October 17, 1989 Loma Prieta Earthquake

Overview

There are 1500 bridges in the five-county area affected by the earthquake of October 17, 1989. Of these, 73 suffered minor damage, 10 bridges needed temporary supports due to major damage, and 10 bridges were closed due to structural damage. Three bridges have one or more collapsed spans. The cost to restore these structures to their operational capacity (before the earthquake) has been estimated at between 1.8 and 2.0 billion dollars. This figure includes the cost to complete the Caltrans retrofit program on the State highway system.

Earthquake Magnitude and Location

The October 17, 1989 earthquake occurred at 5:04 p.m. (PDT). The Seismological Station at the University of California, Berkeley, reported a Richter magnitude of 7.1 for this event. The epicenter of the earthquake is approximately 15 miles northeast of Santa Cruz along the San Andreas Fault. The duration of strong shaking was less than 10 seconds. The epicenter was approximately 60 miles southeast of the location of several major bridges which were damaged in the earthquake.

Reconnaissance Effort

An initial group of 10 bridge engineers and researchers commenced a reconnaissance effort approximately 24 hours after the earthquake. This group grew in number to almost twice this size on Saturday, October 21. Twenty-two bridges were surveyed by three field teams of four to six engineers each. This preliminary survey was completed by late Saturday evening.

The assistance of Caltrans, the California State Department of Transportation, was particularly valuable to the group in the rapid identification of damaged bridges and in gaining access to these structures.

Bridges Inspected

Twenty-two bridges from the North Bay to Watsonville were inspected. These included the Cypress Street Viaduct (the I-880 structure), the San Francisco-Oakland Bay Bridge, the Embarcadero Viaduct, the Central Viaduct, the I-280 viaduct in China Basin, the West Grand Avenue Bridge, the San Mateo-Hayward Bridge, the Route 92/101 Separation Structure, the I-580 Distribution Structure, Sierra Point Overpass, Struve Slough, and the I-980 and 6th Street offramp.

General Observations

- The seismic design code for highway bridges was rewritten following the collapse of several new bridges in the 1971 Sylmar earthquake. Bridges built before this time are therefore known to be vulnerable to major damage in an earthquake and the Caltrans bridge retrofit program was established to address this problem. The performance of both new and old bridges in the present earthquake is therefore of particular interest to the bridge design and research community.

- The greatest damage occurred to older structures on poor ground. The Cypress Street Viaduct is one example; the Bay Bridge is another.

- The Cypress Street Viaduct (I-880 structure) was a two-level, mile-long, elevated freeway structure in Oakland. Each level was a multicell concrete box girder bridge, supported on reinforced concrete frames (bents). Designed in 1951 and completed in 1957, it represented the state-of-the-art, at that time, for this type of transportation structure. It collapsed catastrophically during the earthquake, crushing cars and trucks as the second level pancaked onto the first level. The official death toll is 41.

- Other bridges, of similar design to the I-880 viaduct, would most likely have collapsed if the ground shaking had been of longer duration. For example, severe damage has been sustained by the Embarcadero structure near Market Street, by the I-280 elevated freeway near China Basin, and by portions of Highway 101 near Gough and Franklin Streets.

- Damage to the bent supporting the connector between I-880 and the new I-980 freeway appears to be due to the inadequate shear strength of the reinforced concrete beam-column joint. Since this structure is new, this result has implications for both new and existing bridges. Revisions to the design procedures for joint shear may be necessary.

Some Brief Case Studies

- The Cypress Street Viaduct collapsed in an unusual failure mode, although the weak link in the chain may eventually turn out to be relatively simple, and in hindsight self-evident.

  Factors affecting the performance of this Viaduct include unconfined shear keys; unconfined column steel; a flexible structure constructed on a flexible soil (a soft soil site); variable soil conditions along its length; variations in lateral stiffness due to some bents having flexural pins, some being skewed, and some having three columns at the lower level.

- The collapse of the link span of the Bay Bridge was due to a connection failure and inadequate seat width for the deck girders. The exact sequence of events leading to the failure is not yet clear, although the holding-down bolts of the eastern truss probably failed first, leading to the eventual collapse of the link span (as the girders supporting this span became unseated).

- The twin bridges across Struve Slough west of Watsonville were also severely damaged, one catastrophically. These bridges have approximately 20 spans of skewed reinforced concrete T-beams supported on monolithic pile bents. Shear failures in the tops of some piles, and gross movement of the super-structure, led to the spans falling onto the piles, which subsequently punched through the deck. The cable restrainers, installed as part of the Caltrans Phase I retrofit program, remained intact with no evidence of pounding between segments of the bridges.

- Some of the steel rocker bearings supporting the Navigation Spans of the San Mateo-Hayward Bridge failed in transverse shear. Loss of support did not occur and reinstatement was relatively straightforward. This may not have been the case if the intensity or duration of ground shaking had been more severe.

Recommendations

This earthquake exposed several weaknesses in highway structures. Some were known to engineers from past earthquake experience; some were revealed for the first time and may affect both old and new designs.

- There are approximately 1400 bridges in the State of California which lie inside the 0.5g contour of design ground acceleration and which need their columns to be retrofitted. The completion of this program must be given very high priority. Few, if any, bridges outside of California have been retrofitted even with cable restrainers (Phase I). Other seismically active states should be encouraged to commence a retrofit program without delay.

- The connections of columns to bents has been shown to be inadequate in both new designs and pre-1971 designs. Design provisions must be revised and implemented for new bridge design in the AASHTO Guide Specifications and the Caltrans design procedures. All existing bridges with this type of detail should also be evaluated for inclusion, if necessary, in the Caltrans retrofit program.

- There are technologies currently available for some of the column and joint retrofit problems. However, there are also some difficult technical issues that need to be solved and funding should be allocated to address these problems immediately. Implementation of currently available technologies should occur as soon as funding has been allocated.

- In-depth studies must be performed on all major Bay Bridge crossings to determine their seismic resistance, taking into account the large relative movements that can occur when flexible structures are sited on soft soil, and exposed to strong ground shaking. More stringent design criteria may be necessary for these important transportation structures. It may be appropriate to use an independent consultant or an independent review panel for this work.

- The philosophy of seismic design for major structures should be reviewed especially in regard to the criteria for acceptable damage. An independent panel should be appointed for this task which might also be expanded to include retrofit design criteria and procedures.

Reconnaissance Team Members

The following people were members of the reconnaissance team: Ian Buckle, Bob Cassano, Bruce Douglas, Mary Goodson, Gil Hegemier, Roy Imbsen, David Jones, David Liu, Ron Mayes, Peter North, Nigel Priestley, Chris Rojahn, Frieder Seible, Larry Selna, Bruce Shepard, Ivan Viest, Stuart Werner.

TABLE 10

LARGE SHAKING TABLES

Location	Table Size	Table Weight (tons)	Specimen Weight (tons)	Frequency Range (Hz)	Maximum Table Motion			Actu-ator Force (tons)	Vibra-tion Direc-tion
					Acceleration (g)	Velocity (cm/sec)	Disp. (mm)		
National Research Center for Disaster Prevention, Tsukuba, Japan	15 m x 15 m (49.2 ft x 49.2 ft)	160	Horizontal: 500 Vertical: 300	Horizontal and Vertical: 0 - 50	Horizontal: 0.55 Vertical: 1.0	Horizontal and Vertical: 37	Horizontal and Vertical: ±30	Horizontal and Vertical: 360	1 Horizontal or Vertical
USSR	30 m x 30 m (98.5 ft x 98.5 ft)	1,000	1,760	Horizontal and Vertical: 0 - 50 requested 0 - 15 most likely			Horizontal: 152 Vertical: 51		1 Horizontal or Vertical
Nuclear Power Engineering Test Center, Tadotsu, Japan	15 m x 15 m (49.2 ft x 49.2 ft)		Horizontal and Vertical: 1,000	Horizontal and Vertical: 0 - 30	Horizontal: 1.8 Vertical: 0.9	Horizontal: 75 Vertical: 37.5	Horizontal: ±200 Vertical: ±100	Horizontal: 3,000 Vertical: 3,300	1 Horizontal or Vertical

__Note:__ All shaking tables have an electrohydraulic drive system.

TABLE 11

RECENTLY CONSTRUCTED SHAKING TABLES

Location	Table Size	Table Weight (tons)	Specimen Weight (tons)	Frequency Range (Hz)	Maximum Table Motion			Actuator Force (tons)	Vibration Direction
					Acceleration (g)	Velocity (cm/sec)	Disp. (mm)		
Tongji University, Shanghai, People's Republic of China	4 m x 4 m (13.1 ft x 13.1 ft)	10	15	0.1 - 50	Long.: 1.2 Lat.: 0.8	Long.: 100 Lat.: 60	Long: +100 Lat.: ±50	Long.: 40 Lat.: 30	Long. and Lat.
Ishikawajima-Harima Heavy Industries, Yokohama, Japan	4.5 m x 4.5 m (14.8 ft x 14.8 ft)	20	35	0.1 - 50	Long. and Lat.: 1.5 Vertical: 1.0	Long. and Lat.: 75 Vertical: 50	Long. and Lat.: +100 Vertical: ±67	Long. and Lat.: 116 Vertical: 232	Long., Lat., and Vertical
National Technical University, Athens, Greece	4 m x 4 m (13.1 ft x 13.1 ft)	10	10	0.1 - 60	Long.: 1.5 Lat.: 1.1 Vertical: 1.8	Long.: 90 Lat.: 60 Vertical: 80	Long., Lat., and Vertical: ±100	Long. and Lat.: 32 Vertical: 64	Long., Lat., and Vertical
State University of New York, Buffalo, New York, USA	3.7 m x 3.7 m (12 ft x 12 ft)	20	20	0.1 - 60	Hor. and Vertical: 1.0	Hor.: 76 Vertical: 50	Hor.: ±150 Vertical: ±75	Hor.: 40 Vertical: 72	Hor. and Vertical
Public Works Research Institute, Ministry of Construction, Tsukuba, Japan	2 m x 3 m (6.6 ft x 9.9 ft)	4	25	0.1 - 50	Hor.: 0.7	Hor.: 60	Hor.: ±75	Hor.: 25	Hor.
Hydroproject Research Institute, Moscow, USSR	6 m x 6 m (19.7 ft x 19.7 ft)	25	50	0.1 - 100	Long. and and Lat.: 1.2 Vertical: 1.0	Long. and Lat.: 60 Vertical: 50	Long. and Lat.: ±100 Vertical: ±75	Long., Lat., and Vertical: 100	Long., Lat., and Vertical
University of Kiril and Metodji, Skopje, Yugoslavia	5 m x 5 m (16.5 ft x 16.5 ft)	30	40	1 - 30	Hor.: 0.7 Vertical: 0.4	Hor.: 64 Vertical: 38	Hor.: ±125 Vertical: ±50	Hor.: 100 Vertical: 90	Hor. and Vertical
Ansaldo Meccanica Nucleari, Genoa, Italy	3.5 m x 3.5 m (11.5 ft x 11.5 ft)	9	2.5	0.1 - 60	Hor. and Vertical: 1.65	Hor.: 90 Vertical: 60	Hor. and Vertical: ±75	—	Hor. and Vertical

Note: All shaking tables have an electrohydraulic drive system.

TABLE 11 (Continued)

Location	Table Size	Table Weight (tons)	Specimen Weight (tons)	Frequency Range (Hz)	Maximum Table Motion			Actuator Force (tons)	Vibration Direction
					Acceleration (g)	Velocity (cm/sec)	Disp. (mm)		
Union Carbide, Oak Ridge, Tennessee, USA	1.8 m x 1.8 m (6 ft x 6 ft)	7	34	0.1 - 20	Hor. and Vertical: 0.25	Hor. and Vertical: 30	Hor. and Vertical: ±190	Hor.: 10 Vertical: 12.5	Hor. and Vertical
Toshiba Electric, Kawasaki, Japan	5 m x 5 m (16.4 ft x 16.4 ft)	20	20	0.1 - 30	Hor.: 1.0 Vertical: 0.7	Hor.: 40 Vertical: 25	Hor.: ±75 Vertical: ±38	Hor.: 50 Vertical: 100	Hor. and Vertical
CEN Saclay, Paris, France	2 m x 2 m (6.6 ft x 6.6 ft)	4	5	0.1 - 200	Hor.: 2.0 Vertical: 1.0	Hor.: 100 Vertical: 66	Hor.: ±125 Vertical: ±85	Hor. and Vertical: 20	Hor. and Vertical
HRB at KFA, Julich, West Germany	5 m x 5 m (16.4 ft x 16.4 ft)	25	25	0.1 - 100	Hor.: 2.0 Vertical: 1.0	Hor.: 80 Vertical: 40	Hor.: ±100 Vertical: ±75	Hor.: 50 Vertical: 100	Hor. and Vertical
Water Conservancy and Hydraulic Power Research Institute, Beijing, People's Republic of China	5 m x 5 m (16.4 ft x 16.4 ft)	25	25	0.1 - 120	Hor.: 1.0 Vertical: 0.8	Hor.: 40 Vertical: 20	Hor.: ±25 Vertical: ±12.5	Hor. 50 Vertical: 100	Hor. and Vertical

Note: All shaking tables have an electrohydraulic drive system.

TABLE 12

REPRESENTATIVE EARTHQUAKE SHAKING TABLES IN THE UNITED STATES

Laboratory	Year Installed	Table Dimensions	Maximum Specimen Weight (kN)*	Driving System	Direction of Excitation	Maximum Acceleration† (g)	Maximum Velocity† (mm/sec)	Maximum Displacement† (mm)	Frequency Range (Hz)	Type of Input Wave
CERL (U.S. Army)	1973	3.7 m x 3.7 m (12 ft x 12 ft)	53.4	Electro-hydraulic	X, Z	20 H, 40 V	889	152 H, 76 V	0-200	Multiple
Cornell University	1982	2.1 m x 2.1 m (6.9 ft x 6.9 ft)	26.7	Electro-hydraulic	X, Z	6	800	76.2	0-50	Sine, haversine, square haversquare and ramp
Stanford University	1975	1.5 m x 1.5 m (4.9 ft x 4.9 ft)	22	Electro-hydraulic	X	5	635	63.5	0-50	Random and harmonic
State University of New York, Buffalo	1983	3.7 m x 3.7 m (12 ft x 12 ft)	178	Electro-hydraulic	X, Z	1 H, 1 V	762 H, 508 V	0.3 H, 0.15 V	0-60	Seismic, random, and analog
University of California, Los Angeles	1975	1 m x 2 m (3.3 ft x 6.6 ft)	5	Electro-hydraulic	X	4	2,540	75	0-30	Arbitrary
University of California Earthquake Engineering Research Center	1972	6.1 m x 6.1 m (20 ft x 20 ft)	445	Electro-hydraulic	X, Z	1.5 H, 1 V	635 H, 381 V	152 H, 51 V	0-20	Seismic, random, analog
University of Illinois	1968	3 m x 3 m (9.8 ft x 9.8 ft)	45	Electro-hydraulic	X	7.5	250	200	—	Arbitrary
University of Washington	1978	2.4 m x 1.8 m (7.9 ft x 5.9 ft)	89	Electro-hydraulic	X	0.6	--	76	0-1,000	Discrete and random
Westinghouse	1979	3.1 m x 3.1 m (10.2 ft x 10.2 ft)	31.1	Electro-hydraulic	Y, Z or X, Z	8	2,540	610	0-500	Sine and random
Wyle	1976	6.1 m x 5.5 m (29 ft x 18 ft)	25.0	Electro-hydraulic	X, Y or Z, Y	6	889	152	0-100	Sine and random

*4.5 N equals approximately 1 lb

†H = Horizontal direction
V = Vertical direction

RESPONSES FROM FEMA TO ADDITIONAL QUESTIONS

1. To what extent will floodplain management regulations pose an impediment to reconstruction and redevelopment of earthquake damaged areas in Santa Cruz?

The Pacific Avenue pedestrian mall, which sustained serious damage in the earthquake, lies in the floodway of the San Lorenzo River. A floodway is an area within the floodplain that must remain open in order to convey flood flows. Obstructing a floodway increases upstream flood elevations and potential damages to upstream property owners. Based on information provided by the City, the mall area appears to flood to a depth of 3 to 6 feet during a 100 year or base flood. The City is currently pursuing map revision for the area with FIA's Office of Risk Assessment which, if approved, would remove most of the area from the floodway. The request is based on the loss of the Riverside Avenue bridge which was damaged in the earthquake. This bridge obstructs the flow of flood waters. However, even if this request is granted, the mall area would remain floodplain.

National Flood Insurance Program (NFIP) floodplain management regulations require that structures that sustain substantial damage (50 percent or more of market value) meet the same standards as new structures. Non-residential buildings that are substantially damaged must either be elevated or floodproofed to the 100-year or base flood elevation. A structure in the floodway can be repaired provided they do not increase the obstruction created by the existing structure and meet elevation and floodproofing requirements. If the area is removed from the floodway by FEMA, only the elevation or floodproofing requirements would apply. If the San Lorenzo River channel were upgraded to provide 100-year protection and the area was removed from the floodplain, elevation and floodproofing requirements would not apply.

Note that a portion of this area is an historical district. Some structures in this historic district meet FEMA's definition of "historic structure", however, others do not. "Historic structures" can be repaired without meeting elevation or floodproofing requirements regardless of whether or not they are substantially damaged.

On Friday, October 20, 1989 FIA staff talked to the Dick Wilson, the City Manager, and Joe Hall, planner, for the City of Santa Cruz at the request of Senator Wilson's office. FEMA has forwarded copies of applicable technical publications to the City including information on floodproofing non-residential structures and is expediting the request for a floodway revision. FEMA will provide the City with whatever assistance is required to fully assess the alternatives for the redevelopment of this area.

REPLY TO QUESTION NO.2 FROM SENATOR WILSON AT HEARING BEFORE THE SUBCOMMITTEE ON WATER RESOURCES, TRANSPORTATION AND INFRASTRUCTURE, OCTOBER 23, 1989.

Q. Given the urgency of need to provide disaster assistance to individuals in California, is it possible to waive requirements for verification of damages to individual properties before financial assistance can be provided?

A. On October 21, FEMA staff in Washington and California collaborated on the development of a procedure to provide funds under FEMA's Temporary Housing Assistance Program at the time of the inspection. Once the initial backlog of applications for temporary housing is cleared out, payments will be able to be made in as little as two days after visiting an application center or registering over FEMA's toll-free line. The procedure will work like this:

- Based on the applicant's statements, a check will be cut in the Disaster Field Office on FEMA's own checkwriting system. The amount will vary, but may be as much as six months' rent. The money can be used to pay rent on a temporary place to live or, if the recipient chooses, he or she may put it toward the repair of the house.

- The check will be given to the FEMA inspector who will meet the applicant at his or her home. Upon verifying the facts as stated in the application, the inspector will give the individual the check on the spot. If there's an eligibility problem, the inspector will retain the check and further review will be done in the field office. If the degree of damage is such that insurance or ownership documents cannot be produced, the inspector will take the applicant's word and issue the check.

Because this is a new procedure, FEMA will start with the most needy people first -- homeowners whose houses are destroyed or where there is major damage. We are looking into other routines to cover renters and those incurring only minor damage.

It is important to understand that the Temporary Housing Assistance Program is just one of a variety of sources of government disaster aid. Depending on the legislative or regulatory requirements of these other programs, it may or may not be possible for the agencies that administer them to make similar changes to their procedures. However, these other programs are designed to provide recovery assistance over the long term. Temporary Housing Assistance is intended give immediate aid and is thus the most appropriate place to focus an effort to insure fast delivery.

Questions from Senator Wilson at hearing before the Subcommittee on Water Resources, Transportation and Infrastructure, October 23, 1989:

Question 3: Under what circumstances is it possible to waive the 25% non-federal share of disaster assistance, especially as it relates to assistance for emergency transportation?

Answer:

- Temporary emergency public transportation services are authorized under Section 419 of the Stafford Act. Cost sharing, as referenced in other sections of the Act, do not apply to Sec. 419 of the Act.
- For other Public Assistance projects, granted under Sections 402, 403, 406, and 407 of the Act, the Federal share shall be no less than 75%. If requested by the Governor and determined by the President to be beyond the State's and local governments' ability to pay, the non-Federal share may be waived in whole or in part.

II

101st CONGRESS
1st Session

S. 1775

To amend title 23, United States Code, to provide highway emergency relief for damages resulting from the Northern California earthquake which occurred on October 17, 1989.

IN THE SENATE OF THE UNITED STATES

October 20 (legislative day, September 18), 1989

Mr. Symms (for himself, Mr. Wilson, Mr. Burdick, Mr. Chafee, and Mr. Dole) introduced the following bill; which was read twice and referred to the Committee on Environment and Public Works

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A BILL

To amend title 23, United States Code, to provide highway emergency relief for damages resulting from the Northern California earthquake which occurred on October 17, 1989.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section 125(a) of title 23, United States Code, is amended by adding at the end the following: "Such sums as may be necessary are authorized to be appropriated from the Highway Account of the Highway Trust Fund to be expended under this section for repair or reconstruction of highways on the Federal-aid systems which the Secretary shall find have suffered serious damage as a result of the Northern

California earthquake which occurred on October 17, 1989; such sums are in addition to the sums otherwise ~~provided~~ in this subsection, are not subject to any limitation on expenditure in a fiscal year, are not subject to the proviso in (b)(1) of this section limiting obligations for a single natural disaster, shall be available until expended, are not subject to an obligation limitation for Federal-aid highway and highway safety construction programs, and may be expended on the Bay Bridge notwithstanding the toll provisions of this title: *Provided*, That insurance payments shall be deducted from construction costs.".

SEC. 2. Section 157(a)(3) of title 23, United States Code, is amended by adding subparagraphs (C) as follows:

"(C) EXCEPTION.—The amount allocated to the State of California under this paragraph shall be the amount allocated to such State under this subsection as if 'emergency relief under section 125,' were inserted before 'forest highways' in subparagraph (A).".

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